

Implementation of Project Based Learning for Civil Engineering Students at Universiti Teknologi Malaysia

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Abstract. Implementation of Project Based Learning (PtBL) in Universiti Teknologi Malaysia (UTM) as part of Outcome Based Education (OBE) framework have faced various challenges (i.e revamp on the undergraduate co-curriculum, required high commitments from academicians & faculty and facilities to cater PtBL activities). This paper discusses the effectiveness of PtBL teaching method in an effort to develop the students' soft skills in tandem with the technical or professional competencies; and problems, challenges and potential improvement in the course. The Survey Camp course which is offered at year one of a four years civil engineering degree programme in the Faculty of Civil Engineering (FKA), UTM was chosen for this study. It is a ten days fieldwork in which the students will carry out an engineering survey project from field to finish in groups of five to six students supervised by the academic staff. Assessment of the technical aspects was based on the students ability to meet the minimum engineering surveying's standard whereas the assesment of soft skills was conducted during various sessions of the survey projects. Survey questionnaires were given at the beginning and the end of the course as part of evaluation of the course effectiveness. The research has found that the technical aspects were achievable though with lesser degree for the engineering design. However, on the soft skills, students demonstrated an overall improvement of competency but it was difficult to determine the levels for the average students while the best and poor performers were easily observed.

Introduction

In Civil Engineering, traditional education approaches based on direct instruction of facts and standard methods have been widely practiced. The outcomes of traditional education focused on the content driven learning objectives, which have been determined by the lecturers without external input. However, with current demands from various stakeholders such as the industries, local governments, employers, alumni, parents and students themselves, a transformation from traditional education to Outcome Based Education (OBE) is essential. OBE requires the inclusion of inputs from various stakeholders because the inputs will become the fundamental on the development of OBE in civil engineering co-curriculum. OBE implementations often incorporate a host of many progressive pedagogical models and ideas, such as reform mathematics, co-operative learning (CL), project based learning (PtBL) and problem based learning (PBL). OBE in itself does not specify or require any particular style of teaching or learning.

PBL and PtBL is gaining acceptance in engineering education world-wide[1]. Moesby [2] reported a study on the performance of students from Aalborg University, which implement PBL

teaching method, while Technical University of Denmark, which is still applied conventional taught. The finding supports very well the edge of graduates of PBL institution have over those graduated from a conventional taught institution. The study have acknowledge both Danish institutions concerning professional competences, but PBL approach had significantly improved the soft skills and professional competencies compare with conventional techniques.

UTM had implemented OBE since 2003, the implementation of OBE had lead to introduction of PtBL and PBL in the UTM co-curriculum. However, the move towards encouraging academics staff to adopt PtBL or PBL seemed rather slow. The main challenge is the need to transform the paradigm of the majority of lecturers that are used to the conventional teaching methods. One of the major concerns is the high number of students in a class that could cause difficulties in facilitation and assessment. Whereas most PtBL or PBL implementations have less than 30 students per class, however a typical class at the UTM consists of 40 to 50 students and some common subjects may have up to 120 students. In addition, adopting PBL with just 14 weeks in a semester to cover the required content is challenging, if not impossible. There were also those who were just resistant to any form of change. It was clearly evident that persuading lecturers to adopt PBL was going to be an uphill battle. Those opting for change require time to adapt, implement and gain experience in PBL techniques. It is also important for those promoting the technique to show evidence of the effectiveness of PBL for engineering education [3].

In this paper, the authors described the efforts in implementing project based learning at Faculty of Civil Engineering, Universiti Teknologi Malaysia, Johor. Project Based Learning (PtBL) will encourage student centered learning and soft skills improvement. Additionally the teaching methodology will give positive development on co-curriculum of Bachelor of Engineering (Civil) programme. The course allows the first year students to experience of practicing engineer environment. Survey Camp introduces the usage of latest technologies of surveying tools in civil engineering projects. It also address problem solving on the civil engineering tasks and development of soft skills such as team-working, leadership and communication skills. Assessments and feedback from academic staff and students were used as tools to evaluate the outcome of the implementation of PtBL. The objectives of this paper are (i) to evaluate the effectiveness of PtBL teaching method in an effort to develop the students' soft skills in tandem with the technical or professional competencies, and (ii) to identify problems, challenges and potential improvement.

Project Based Learning and Problem Based learning

Helle, et. al[4] , Barrows [5] and Walker [6] had established the crucial aspects of PtBL and PBL which could be used as a guidelines to differentiate both learning techniques as shown in Table 1. There some similiarities, yet a clear difference could been seen in Table 1.

Table 1: Crucial aspects of PtBL and PBL [4][5][6]

Project Based Learning (PtBL)	Problem Based Learning (PBL)
<ul style="list-style-type: none"> Involved in the solution of a problem 	<ul style="list-style-type: none"> Problems are to be unresolved and ill-structured
<ul style="list-style-type: none"> The solution often set by the student but not necessarily 	<ul style="list-style-type: none"> Learners should determine what it is they need to learn, illustrating that it is a student centered approach
<ul style="list-style-type: none"> The learners control the learning process (teacher is an advisory at a distance) 	<ul style="list-style-type: none"> Learners orient the learning process (tutor is present throughout the learning process)
<ul style="list-style-type: none"> Commonly result in an end product (e.g. report, computer programme and model),” Most often involving the construction of a concrete artifact. 	<ul style="list-style-type: none"> Real world problems should be chosen, “making PBL an authentic learning process”
<ul style="list-style-type: none"> Students' activities are directed to constructing the product 	<ul style="list-style-type: none"> Students' activities are directed to studying the problem
<ul style="list-style-type: none"> Work often goes on for a considerable length of time 	
<ul style="list-style-type: none"> Both function with small groups of students and start out with a problem 	

Survey Camp

The implementation of Survey Camp programme is based on the Civil Engineering Handbook and Survey Camp Handbook published by Faculty of Civil Engineering [7][8]. Another reference documents is the Engineering Programme Accredital Manual 2012 (EPAM) [9]. Students who are attending this camp have successfully completed the theory and practice of engineering surveying course. Nevertheless the surveying projects that were undertaken are ‘stand alone’ projects with emphasis on the understanding of the concepts involved. Therefore, this Survey Camp will provide training of the surveying work involved in a typical civil engineering project. The Survey Camp is offered at year one of a Civil Engineering Degree Programme. It is a ten days field works with one credit addressing six course learning outcomes (CO) which will contribute to six Programme outcomes (PO). The details of the learning and programme outcomes are as follows:-

Table 2: Survey Camp course learning and programme outcomes [7]

Course Learning Outcomes (CO)	Programme outcomes (PO)
CO1: Apply theory into practice	PO1: Ability to apply knowledge of science, mathematics, civil engineering principles and other relevant field of studies to solve complex engineering problems
CO2: Identify and solve surveying problems in Civil Engineering	PO2: Ability to analyse and use appropriate techniques, resources and modern tools to solve complex engineering problems and activities
CO3: Communicate effectively when presenting results and ideas	PO3: Ability to design solutions and use appropriate Techniques
CO4: Justify methods and equipment to suit purpose of survey	PO5: Ability to communicate effectively and with confidence including complex engineering activities
CO5: Function effectively in a team and play role sparingly with other members to achieve common goal	PO7: Ability to function effective as an individual or in team to achieve common goals in diverse teams and multi disciplinary settings
CO6: Lead and manage a team	PO9: Ability to demonstrate entrepreneurial skills, lead and manage a team effectively in multi disciplinary environment with self-assurance

During the course, the students carried out an actual surveying and design project supervised by the academic staff assists by technical staff. The Survey Camp gives a holistic view of the surveying activities needed prior to and during the construction stages of a civil engineering project. Furthermore, the Survey Camp activities will train the students in planning and executing survey work on a larger scale. The surveying work involved depends on the type of project undertaken, but normally include establishing horizontal and vertical controls, detailing, earthwork calculations and setting out. Student will be assessed based on their oral presentation and written reports submitted at the end of the camp. The basic and concepts of surveying with emphasis towards engineering surveying will be introduced. Common methods of field procedures, bookings and reductions of observation are adopted. By end of the course, students should have the ability to apply theory into practise; identify and solve surveying problems in civil engineering; communicate effectively when presenting results and ideas; think positively and making sound decisions by upholding ethics and function effectively in a team to achieve a common goal[8].

Course Project

A scenario was designed for the purpose of practical training, to simulate an actual engineering surveying project. Teluk Gorek Chalet and Camp Site (TGCCS) as a client had requested a proposal of land reclamation on existing site. The site was located about 30 km from Mersing, a city in Johor, Malaysia. The Survey Camp students was appointed to carry out engineering surveying work (traverse, levelling dan detailing) on a piece of land of about 0.6 hectare and to submit a survey plan that will be used in expansion of existing Chalet and Camping site.

Course Implementations

Each Survey Camp group consists of 5 to 6 students from various background i.e gender and ethnicity. Total number of survey group is based on numbers of student registered for the course. A group leader was appointed to each team while the others member must take parts in all projects activities as a team member. However, each team members were appointed as project leader for different project. The daily routines start with a morning briefing by the Survey Camp coordinator (academic staff) followed by group discussion to plan and execute the project activities. The results from discussion were reported to the facilitator in-charge for the particular project by project leader and all team members should present during this session. After checking process the group then execute their survey work for the particular task. During the initial few days, the whole group went out to carry out the field work. However, if they face any problem or any obstacles in completing their projects task, the project leader have to discuss with team members to review existing planning and project execution . The group leader might decide to leave some members behind to do the calculation, data processing, data analysis, plotting and preparation of presentation materials.

Course Outputs

The course outputs required from each group were the group report, the survey plan and the conceptual design plan of the proposed reclamation project. The group report including of daily survey field books, calculation sheet, reclamation volume estimations and the write-up for conceptual engineering design. These outputs or products formed the basis for the assessment of the individual and team performance. It was the duty of the team leader and project leader to ensure that the team daily activities and projects were carried out accordingly and any problems were solved collectively. The team leader and project leader had to ensure that each team member worked as planned. In a way the appointment of a daily report was a check and balance measure to ensure that the survey team work together. Based on the progress of work, it had to be assumed that this strategy worked. During the evening oral presentation, the group matters, problem encountered and related issues were discussed

Course Assessment and Evaluation

The assesment of students performance was conducted through written report (i.e field work books and calculation) and oral presentation by academic staff. It should be pointed out that the students were not graded but rather they were assessed either to have met the requirement of passing the course or the contrary.

Effectiveness of the course was evaluated through survey questionnaire. The questionnaire focused on the implementation of a Project Based Learning (PtBL) teaching method in an effort to develop students' soft skills in tandem with technical or professional competencies are discussed in this section. The entry and exit survey questionnaire for Survey Camp (see Table 3) were handed to all participants at the beginning and the end of the course. For 2013 survey questionnaire were conduct on entry and exit. However, for year 2012 the survey quuestionnaire only conducted during exit.

The questionnaire feed back was collected from four consecutive Survey Camp session (February2012, July 2012, January 2013 and August 2013). Figure 1 and Figure 2 shown the students achievement in various soft skills attributes such as communications (PO5), teamworking (PO7) and leadership skills (PO7). Attributes of PO1 was not included by the reasearcher in the questionnaire. However, the achievement of PO1 could be reflected by achievement in PO2 and PO3. A significant increament between entry and exit in 2013 survey camp on all soft skills(PO2, PO5, PO7 and PO9). Overall a similar trend was recorded on students achievement on entry and exit survey in January and August 2013.

Table 3: Example of Entry/Exit Survey Questionnaire

QUESTIONNAIRE

PO2 USE TECHNIQUES, SKILLS AND MODERN EQUIPMENT

- a) Able to perform the test
- b) Able to decide usage of equipments
- c) Able to use equipments
- d) Able to operate the equipments
- e) Able to analyse and design using computer softwares

PO3 ANALYSE, INTERPRET, DEVELOP AND CONDUCT EXPERIMENTS, DESIGN COMPONENTS SYSTEMS AND PROCESSES.

- a) Able to analyse, interpret, fieldworks results
- b) Able to conduct fieldwork
- c) Able to analyse problems
- d) Able to relate the practice with fieldworks
- e) Able to utilize theories related to experimental work

PO5 COMMUNICATION SKILLS

- a) Able to present written information.
- b) Able to present information and express ideas
- c) Able to engage the audience
- d) Able to answer questions and comments
- e) Able to make effective use of visual aids and multimedia

PO7 TEAM WORKING SKILLS

- a) Able to show positive attitude and respect other team members
- b) Able to contribute as a valuable team player
- c) Able to give ideas and relevant information
- d) Able to interact effectively and actively within a group
- e) Able to be proactive and support ideas
- f) Able to listen and open to ideas

PO9 LEADERSHIP SKILLS

- a) Able to motivate people
- b) Able to inspire people
- c) Able to be an effective decision maker
- d) Able to be somebody who is dependable
- e) Able to lead a group

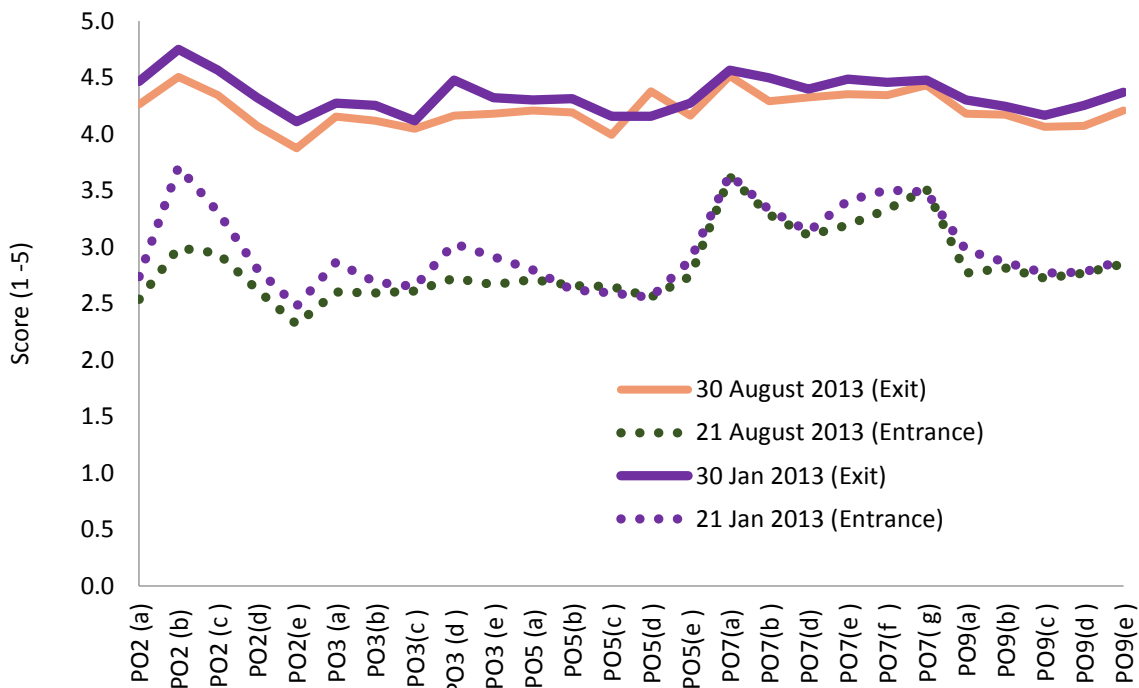


Figure 1: Comparison of Entrance and Exit Survey 2013 on soft skills development

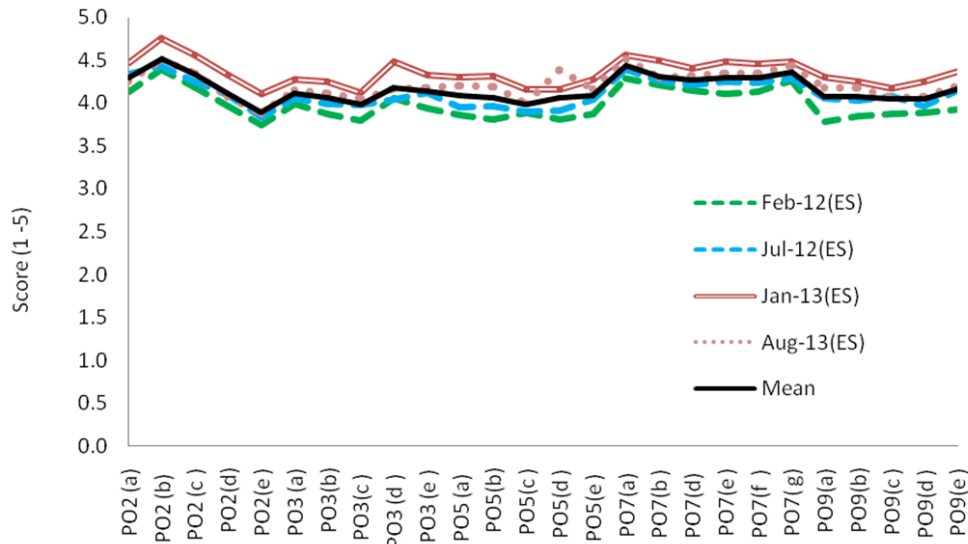


Figure 2

Figure 1 shows the exit survey results from four consecutive survey camp held in February 2012, July 2012, January 2013 and August 2013. Figure 2 shows exit survey results, a similar trend on all four survey camp conducted . The results obtained for year 2013 is above mean trend line compared to the results obtained from year 2012. Exit survey achievement for year 2013 is slightly higher compared to year 2012. Various factors such as student academic achievement, group communication and understanding, group members technical skills in equipment especially in total station handing, group leader leadership skills and organiser continuous quality improvement may contribute to achievement between year 2012 and 2013.

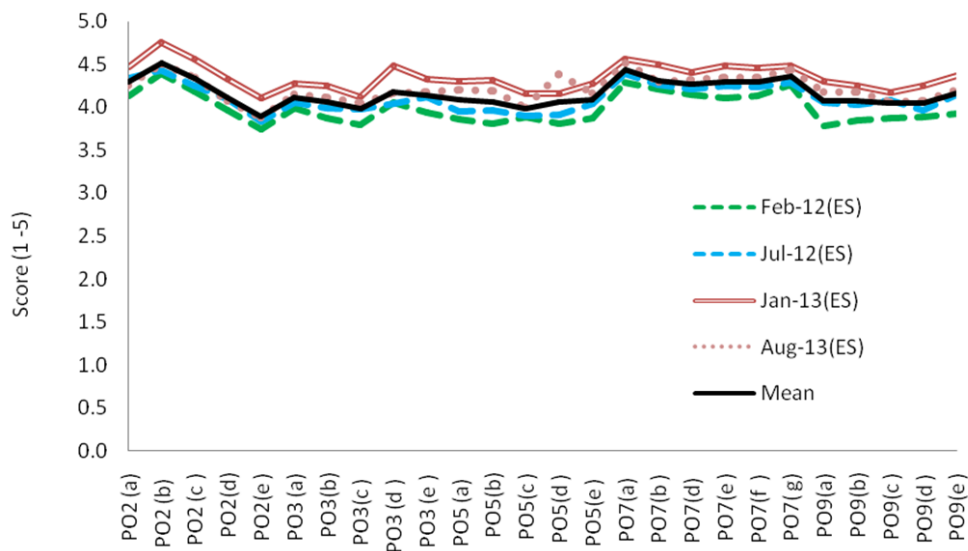


Figure 1: Comparison of Exit Survey (ES) on soft skills development between 2012-2013

Effectiveness of Project Based Learning

All groups successfully completed their assigned tasks and submitted the required outputs standard within the stipulated time frame. In accomplishing these tasks, each group had undergo the necessary field surveying work, compiled and analysed the fieldwork data, produced the survey plan, developed the conceptual engineering design of proposed land reclamation and earthwork estimation. Based on the course outputs submitted by the students, it could be argued that the course outcomes as identified for the course had been achieved. As far as the soft skills were concerned, all students had participated actively in all planned activities and individually could be observed

communicating and working as a team. The effectiveness of PtBL were best proved through both Figure 1 and 2 which clearly shows the enhancement of the students attainment of their soft skills. The CQI done in the previous semester also exhibited better results.

Feedback

Based on students feedback, the Survey Camp course have improved their technical and soft skills based on comparison between start and end of the course. They were opinions that the course outcomes, teaching methods and materials as well as learning experiences were beneficial. The following statements describe some comments given through the questionnaires:-

- a) "I appreciate the opportunity given here, it have increase my understanding on the operation the equipments"
- b) "Need a workshop before Survey Camp, that will briefly discuss the incoming project in Survey Camp, so the student will have better understanding"
- c) "The duration of Survey Camp should be extended because that will help the participants to gain more experience"
- d) "Every project/task has been conducted successfully and the theories learned were applied in the fieldwork. I had gain a lot of ideas and appreciate every calculation that had been done in class (theory) as I can applied it effectively to my group fieldwork. – Female/Age 20
- e) This Survey Camp was fun and enjoyable.

Overall the comments were positive, however, there a few constructive comments should be taken into account such as requirement to have a short workshop before the course, insufficient of water supply and insufficient time for succesfully accomplish the task properly. All the constructive comments were resolve within the duration of Survey Camp or after the next session of Survey Camp.

Challenges and Problems

The main challenge faced by the both academic and technical staff and the students were categorised into three stages as follow:-

Prior to Survey Camp.

The academic and technical staff had to plan the Survey Camp three months prior to Survey Camp. Committe members, financial expenses, equipment availability, logistics and accommodations were among the important things to be taken into account during the preparation. The academic staff had to request budget from the faculty to cover logistic cost, equipment maintenance and staff allowances. Besides that, the technical staff will conduct inspection on the equipments, if a repair or maintenance is required. Generally more than 90 students (approx. 18 survey groups) will attend the survery camp, a lot of equipments (such as global positioning systems (GPS), total stations, auto-levels, laptops and others surveying tools to be mobilise from UTM to the Survey Camp site. The academic and technical staff had to plan and execute the logistics plan to accomodate the needs of equipments and the accomodations. Proper plan prior to Survey Camp was required in order to avoid uncertain problems to be faced which may delay the execution of the Survey Camp.

During Survey Camp

The project that the students worked on real civil engineering survey project need to be completed within a short duration of the course. The students were primarily focused on the achievement of the course outcomes. While the academic staff, had another goal of ensuring that all projects/task given to the students will be completed according to the survey standard. Therefore, a dynamic interaction between Survey Camp organizer (academic and technical staff) and students should be in place to permit the smooth process to achieve the goal of the Survey Camp. Other than this, the academic staff had to ensure the other aspects including the day to day running of the

Survey Camp (i.e. transportation, logistics, student welfare and safety) are on the top of their priority. Student welfare and safety were a major concern to the Survey Camp organizer, a systematic guidelines applied to the student as precaution. However, a close monitoring by organizer and full co-operation by students were required in order to achieve this concern. The course was designed such that, the desired course outcomes could be achieved. With previous experiences it was anticipated that the students would go through learning experience that consolidated their understanding of engineering surveying and at the same time enhanced their personal competencies.

Post Survey Camp

The equipments should be mobilised back to UTM with proper planning upon the end of the course. Prior to that, a basic cleaning of the equipment and pre-check was conducted by the student, then the equipments returned to the technical staff. If there is any damages, the student need to report to staff for further action. The staff will conducts detailed checking in the faculty. There will be a post mortem on the outcomes course by the academic and technical staff. Continuous Quality Improvement (CQI) will be discussed among the staff in order to increase the achievement and the effectiveness of the course. Future planning of equipment maintenance and purchase will be forwarded to the faculty as future budget planning. Students' assessments results will be analysed and reported to the faculty for future CQI in the curriculum.

Further Potential Improvement

Based on the outcome of the recently completed Survey Camp course, potential improvement could be achieved through the implementation of several measures. The organization of the whole Survey Camp could be enhanced. It could be more meaningful if the course is offered in year two as to allow for the student to acquire better engineering knowledge. The students will be in a position to gain much more from such a beneficial course. Further details should be to look into assessment of the soft skills especially on assesment grading rubrics. Similarly, individual component should be identified in order for a grading reflective of the levels attained to be awarded to student in place of the present pass-fail grade. This change will enhance the effectiveness of the program as the students will work harder to gain better grades or to avoid failing. However, it should be highlighted that these changes could cause an increase in terms of the overall cost and the manpower requirement of running the course. Additional special budget should be sought from the university authority as this Survey Camp was implemented with the normal budget allocation. The potential improvement also has been suggested by researcher in Universiti Malaya and Queensland University of Technology in similar course, especially on course implementation on year two of bachelor, grading assessment and special budget [10][11].

Conclusions

The outcomes of the research on the hard skills, engineering survey and conceptual engineering design, were achieved though with lesser degree for the engineering design. The results produced by the students was acceptable and fulfill the minimum requirement of survey standard. The conceptual engineering design however shows some shortcomings. This could be simply explained by the fact that the student had completed all the tasks related to engineering survey by the time they went through the Survey Camp. On the other hand, the students hardly had the necessary engineering design knowledge as their earlier courses focus more on engineering basics e.g. drawings, mathematics, materials and engineering mechanics.

With regard to the soft skills, the students benefited from the ten days course by showing a marked enhancement in their personal competencies level. As the course progressed, the various aspects of communication between the students, better teamworking skills were acquired and improvement in leadership skills. However, it was difficult to determine the levels attained by

individual students in particular the average, or middle ranking students. The best and poor performers were easily observable.

Overall, the Survey Camp can be considered as a success considering that nearly all course outcomes had been achieved as intended. However, there are several aspects that could be improved to enhance the students' learning experience. The overall management of the course should be looked into in particular the assessment grading rubric of soft skills. The possibility of offering the course upon the completion of year two should also be considered by the faculty. The student will be more matured and they would have gathered more design experience which will benefit them especially for the conceptual design component of the course.

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