



Enhancing Sustainability Awareness in Undergraduate Civil Engineering Education Using Project-Based Learning

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Introduction

Sustainable development is now the central core of missions in numerous international and national organizations and institutions. In a nutshell, based on the earlier definitions of this concept, it is essential to utilize approaches that make the development sustainable for societies to meet their current needs without compromising the need of future generations to environmental resources (Kate et al. 2005). Therefore, the role of higher education to promote awareness for a new human perspective in terms of sustainability – of particular in the case of generations under engineering training- is paramount.

Project-Based Learning (PBL) provides the ground to deal with challenges - likely to be experienced in educating the new generation of engineers that are expected to be aware of the sustainable growth indicators. On the basis of the avenues established from experience in engineering education, PBL aims to support and enhance the learning experience of students towards building communities of reflective practitioners (Ayas and Zeniuk 2001). During completion of a defined PBL learning project, the learner develops Inter-disciplinary problem-solving abilities and graduate attributes that are grounded on the comprehension of threshold concepts inherited from a smooth transfer of knowledge (Kolmos and de Graaff 2014). These in turn contributes to improving the international employability and students' learning experience; hence, the academic citizenship of learners are to be blossomed with the fruit of knowledge beyond the campus.

Objectives

The main objective of this study is to qualitatively assess the potential adaptation of PBL approaches for enhancing the sustainability awareness amongst undergraduate civil engineering students. In addition, it has been attempted to appraise the learning experience of the learners based on the quality of their developed dissertation report output.



Fig 1. CEB developed in this study.



Fig 2. An example of CEB tested in this study.

Methods

PBL approaches in the context of supporting learning for students substantially rely on the learners efforts to acquire knowledge and support of teacher in terms of know-how (Bell 2010). It is expected that in PBL learning, the students solve real-world problems; ensuring that through several phases of planning for knowledge transfer, the learners learn the fundamental concepts whilst being reliant on their own skills and efforts to complete the necessary tasks (Bell 2010).

This study was established based on the generally-accepted pillars of PBL approach as defined in numerous studies (e.g., Bell 2010; Musa et al. 2011). In line with the objectives of United Nations sustainable development goals (i.e., Griggs et al. 2013), a project-based learning approach was planned to assist the undergraduate (UG) civil engineering learners (a total of 8 students) to enhance their awareness in sustainable development to address eco-friendly approaches in construction. It is commonly accepted that rapid development in industrial construction has tremendously contributed to global warming. The amount of cement used in the construction industry can be enumerated as one of the most important factors that contributed to this phenomenon (Peters et al. 2012). Therefore, in this study, the students in their "research dissertation" module were assigned to look into the background studies in relation to techniques that can potentially reduce the amount of cement in construction industry. The technical details related to approach can be found in Motamedi et al. (2015). Figures 1 and 2 demonstrate a sample the Compressed Earth Blocks (CEB) developed and testing during this study. For further details refer to <https://tinyurl.com/y8kbj7v>.

Results

In this study, a total number of 8 UG civil engineering students undertaking the "research dissertation" module were advised to choose a topic related to reduction of cement in construction industry towards enhancing their understanding for sustainable development. Based on PBL approaches, the students satisfactory completed their experimental and analytical study for development of sustainable construction material. It has been attempted to advise students to use eco-friendly materials for development of composite materials (e.g., peat, saw-dust, PFA, and GGBS).

Based on the results of the carried out studies, the students were successful to introduce innovative and sustainable composite materials to be used in construction industry. The knowledge transfer approach based student-driven and teacher-assisted was proven to be enhance the learners perception in terms of sustainable development growth indicators. Figure 3 demonstrates the average research dissertation marks based on the assessment of the supervisor and second assessor (6 different individuals) and the total module mark. The average of these marks was 67 ± 1.88 which indicates a good distribution of marks; hence, in terms of assessment it is apparent that based on the academic judgment of 7 experts in the field the learners could have achieved very good knowledge on the subject matter. In addition, the outcome of their works would potentially have practical applications to be proposed to industry should necessary further investigation on the technical details be carried out. These results are inline with the principles of the PBL objectives (e.g., Bell 2013).

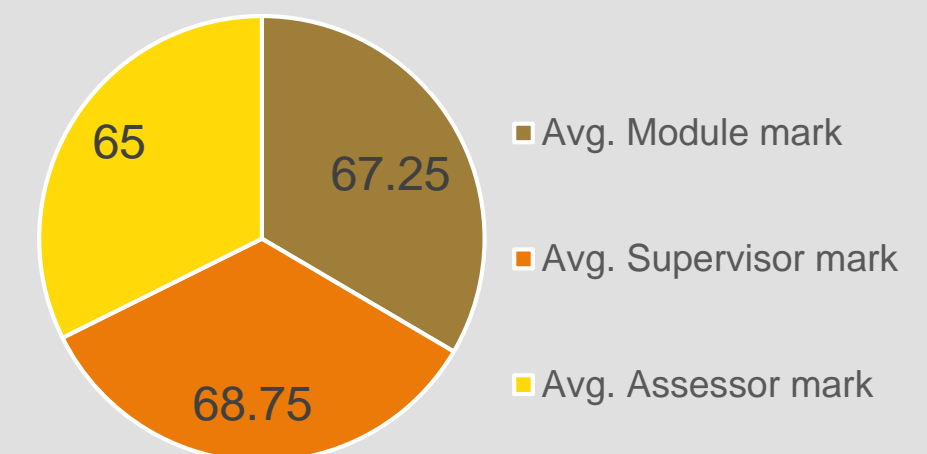


Fig 3. Average research dissertation marks.

Based on the students experience reflected in the acknowledgement of their dissertation, overall, the students had a very good learning experience and satisfaction. Based on the acknowledgement section of the reports, the students were very satisfied with the student-driven; teacher-assisted learning style that helped them understand the subject matter and develop self-reliance skills for engineering problem-solving procedures. Based on their statements in acknowledgment, they enjoyed the relaxed environment created by the PBL approach for working towards completion of their study which was made possible based on phase-based planning.

Conclusions

Based on the results of this study, the following conclusions can be drawn:

- There is an immediate need to address the matters arising from the global warming. These have been aligned with UN sustainable development goals. It is apparent that the need for increasing awareness in the new generation of engineers for sustainable development indicators are essential.
- PBL approaches rely on student-driven and teacher-assisted learning style towards enhancing the knowledge transfer process in terms of self-reliance and graduate attributes which in term improve the employability of the students. Hence, incorporating the PBL approaches would contribute towards the academic citizenship of learners, to be blossomed with the fruit of knowledge beyond the campus.
- Based on the results of this study, the average marks of students undertaking the "research dissertation" module on the account of assessment of 7 subject experts were 67 ± 1.88 out of 100. In addition, as per learners' statement in the acknowledgement of their report, it is apparent that the student satisfaction and learning experience have both were in very good statistics.

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