Implementing Project-Based Learning for Sustainability Management Course at Postgraduate Level

Marfiah Ab Wahid[1*], Wei-Koon Lee[1], Fauzi Baharudin[1]

[1]Faculty of Civil Engineering, Universiti Teknologi MARA,
40450 Shah Alam, Selangor, Malaysia
marfi851@salam.uitm.edu.my
*Corresponding Author

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Abstract: Project-Based Learning (PBL) is a teaching method in which a student gains knowledge and skills by working for an extended period of time to investigate and respond to an authentic project, engaging in complex questions, problems, or challenges. The PBL for sustainability management course was designed to achieve the student learning outcomes and to help develop skills such as critical thinking, problem solving, communication, collaboration, and self-management. The project features a real-problem in an Orang Asli Settlement at Pos Kuala Mu, Perak. The challenge for the students is to propose sustainable eco-tourism activities and at the same time conserve and uphold the traditional knowledge and Orang Asli heritage. The target of this project is to increase the income of the Orang Asli and thus improve their economic sustainability. Students were engaged in a rigorous, extended process of asking questions, finding resources, applying their knowledge and gathering information. The project was successfully implemented and can be concluded that implementation of PBL in sustainability management course for postgraduate students achieved the course outcomes and the programmes outcomes.

Keywords: Project-based Learning (PBL), Sustainability Management, Postgraduate

1. Introduction

The new era of globalization and 21st century learning have brought many changes to the educational setting all around the world (Dalim, Azliza, Ibrahim, Zulkipli, & Yusof, 2019). One of the changes is the introduction of Project-Based Learning (PBL). Project-Based Learning (PBL) engages students in solving a real-world problem or answering a complex question leading to the completion of a project or product at the end of the learning process. PBL often requires students not only to gather the relevant resources, plan and organize the works to be carried out, and manage the activities throughout the project duration, but also to collaborate, design, revise, and share their ideas and experiences with authentic audiences and supportive peer groups. The main purpose of PBL is to provide a platform and learning environment for students to put learnt theory into practice and gain new skills throughout the process as they apply, synthesize, prioritize, summarize and conclude from the interactive activities to arrive at an in-depth understanding of the important key concepts of the course. These skills acquired are not only invaluable professionally, but transferable and useful on other aspects of life.

For the reasons stated above, PBL is selected as one of the teaching methodology for the course Sustainability Management, offered under the master by coursework programme in Faculty of Civil Engineering (FCE), Universiti Teknologi MARA. It is a core subject to six (6) different master

programmes at FCE, namely M.Sc in Structural Engineering, M.Sc in Environmental Engineering, M.Sc in Geotechnical Engineering, M.Sc in Construction Management, M.Sc in Highway Engineering, and M.Sc in Water Resources Engineering.

The theory and concept of sustainable management is crucial for civil engineering graduates, and more so, postgraduates who are likely to play a more important or senior role in a project where they are appointed to. The course deals with the implementation of sustainability in civil engineering with respect to environmental, economic and social dimensions. Adoption of PBL in this course helps to instill understanding beyond that of book knowledge and rote learning of how sustainability concepts may be incorporated in these dimensions, which is vital to provide optimal solutions to practical problems. The course also addresses issues related to regulatory and institutional issues, as well as the management tools for managing identified problems.

In this paper, we describe the PBL project assigned to students enrolled in the postgraduate Sustainability Management course in FCE, UiTM. The design of the project is described, followed by the project execution, assessment, and outcome. Our emphasis is to ensure that students conduct the project by adhering to environmental ethics, establishing teamwork, demonstrating leadership, and formulating appropriate solutions using their scientific skills in solving the problems given.

2. Project Framework

According to Bell (in Valls-Barreda, 2016), PBL is an innovative approach to learning that imparts a multitude of strategies critical for success in the twenty-first century. It is a student-driven learning aiming to create independent thinkers and learners. Hence, the important factor in designing the framework for effective PBL in postgraduate study focuses on enabling the students to plan, investigate, synthesize the information, and produce new innovative solutions to real case scenarios.

The design of the PBL framework for the postgraduate course Sustainability Management is based on a number of principles, with adaptation considering the local conditions (Gupta and Wachter, 1998; Clear et al, 2001; Melin et al., 2006). The approach focuses on how and what students learn, where the key role of the lecturer/ instructor is to develop the context of the project and to facilitate effective learning to take place. The framework emphasizes a holistic and deep approach to learning, where scientific knowledge and skill is put to use to solve complex real life problems with actual stakeholders. The assessment assigns high weightage on students' analytical skills, creativity, and self-awareness – three important aspects with salient position in the emergent framework throughout the project. It is therefore important for the lecturer to design the project to give students room and opportunities to relate new knowledge to past knowledge, and to relate theoretical ideas to everyday experience and real-life situations (Ramsden, 2003).

The framework of the project, which is divided into four main stages, namely design the idea, construct the idea, evaluation and public presentation. The entire project, from inception to completion, is carried out within the time frame of an academic semester of 14 weeks, where the actual time window available for planning, execution and the final winding up including report compilation is approximately 3 months.

Based on the project location, characteristics of the local community, the project purpose or known problem, project constraint, and other relevant parameters given, the first stage calls for all students to engage themselves in producing "design ideas" which typically involves a brainstorming session after the background information has been perused. Students are expected to review the 17 criteria in UN's Sustainable Development Goals (SDGs) to select the most appropriate goal or theme to be addressed in the context of the project. Ideas are to be objectively and critically discussed where all aspects of sustainable management, including the environment, social and economic dimensions, are assessed and evaluated before the best idea is chosen.

The second stage involves "construct idea" where students begin the detailed work to plan, investigate and synthesize the information. Each group develop their respective group resume which identify the strength and limits of each team member. This includes ability, inclination, expertise, etc. Preparation of the group resume promotes communication, understanding and expectations between team members who are from diverse backgrounds. The process allow for better integration of individuals into the project team to complement one another towards achieving the goals of the project. Each group then derives and proposes their approach or methodology for the project based on the team capacity, addressing the chosen theme from SDGs with appropriate assessment criteria and in-depth assessment. Members of the group are expected to execute the idea constructed in good and effective cooperation, making necessary fine tuning or adjustment in the process based on feedback and circumstance. The project final outcome is to be compiled into a report to be submitted for review.

The evaluation of the project is based on the Programme Outcomes (PO) and Course Outcomes (CO) of the course. The generic attributes to be evaluated are how the students use their knowledge and skill to make ethical decisions taking into account the impact on the society, environment and economy. Soft skills, including leadership and managerial skills, are also evaluated. Evaluation is guided with designated rubric in order to maintain objectivity.

The culminating event of the project is a public presentation in which students present to local communities and related agencies the content they have come to understand, how they apply their knowledge and their proposed solution for the project. This element in itself imposes upon the project a true sense of relevance with real life stakeholders who may be for or against the solution proposed by the team. Students engage in not only one-way communication of their idea to the audience, but to gather response, and address feedback which forms another important part of the learning.

Schmidt (2010) cited Dewey's famous quote which said that students do not just learn from experience, but they should also learn from reflecting on their experience. Reflection on the content knowledge and understanding gained helps students to internalize what they have learned and think about how it might be applied elsewhere beyond the project. Reflection on skill developed helps students to identify the gap in skill set to drive individuals into setting new goals for further growth and development. Reflection on how the project was perceived and conducted helps students to think how they could have done better, how they could have avoided certain shortfall, and how they might approach their next project with better pre-conception and implementation. It also helps the lecturer/ facilitators to improve the quality of their PBL design in an on-going quality improvement exercise.

3. Implementation of the Project

3.1 Study Area

POS Kuala Mu a remote Orang Ali settlement of the Temiar tribe, located about 70 km from Sungai Siput, in the State of Perak. It is strategically located near the confluence of Sungai Mu and Sungai Perlus which has 4 local villages, Kampung Bersah, Kampung Gepeh Hulu, Kampung Gepeh Hilir and Kampung Kuala Mu. There are about 160 families including the neighbouring villages. Approximately half of the population are Muslims, and the rest are either Christian or animistic. Their livelihood is hunting and gathering forest produce. Some amongst the younger generation left to work in towns and cities.

Lately the Government has started initiatives to bring them to the mainstream society and introduced modern elements into their lives. There are now brick houses, where solar panels are installed at every house to generate the electricity for daily use. Mobile cellular coverage has also been provided, where the telecom broadcast station is powered by a diesel generator-set. The secondary school has been equipped with internet facilities.

Meanwhile, the only access road remains as untarred mountain road, which is frequently inaccessible during rain. A four-wheel drive vehicle is typically required in order to get in and out of POS Kuala Mu. In 2013, under a project by the Malaysian Armed Forces (MAF), 16.7 km of road connecting between POS Legap and POS Kuala Mu was upgraded. This upgrade has shortened the travel time between the settlement and Sungai Siput town from 8 hours to about 2.5 hours and it has become a tourist attraction for off-road activities.

Development of recreational chalets and resorts has since been carried out by the local youth community to promote ecotourism at the destination. These projects not only become a stepping stone for the local community to tap into the economic growth, but at the same time encourages conservation and sustainability to upkeep the traditional Orang Asli heritage which is of great value and attractions to both locals and foreign visitors. Although some physical development work has already taken off, the community is still lacking in terms of ideas and skills on how to create activities and build infrastructure in a sustainable manner. The challenge of this project is to propose to the community on how to develop the area into a sustainable recreation area.

3.2 Group Resume

Social interdependence theory postulates that through a shared goal, effective teams learn to work together for the overall success of the group. Learning is facilitated when group members strive to motivate and support each other. These cooperative efforts, known as promotive interaction, are essential elements of collaborative learning processes (Johnson & Johnson, 1999). Therefore, it is important for each group to get to know the strength and ability of each team member and utilise it to achieve the objective of the study. A complete group resume consists of student name, educational background and academic major, general knowledge of course content, specialized knowledge and skills (Barkley et al. 2005). Table 1 shows an example of a student's group resume.

Table 1: Group Resume

Student name	Educational background and academic major	General knowledge of course content	Specialized knowledge	Skills
Mohd Haziq bin Mohd Nazir	Civil Engineering (Project management)	50 % (Working experience with MRT corp)	Project management, safety and health at construction site	Time management, health and fitness
Muhammad Taufiq bin Razak	Electrical Engineering	20% (Fresh graduated)	AutoCAD MS Project MS Office	Problem solving

Student name	Educational background and academic major	General knowledge of course content	Specialized knowledge	Skills
Mohamed Aimirul Syafiq bin Mohamod	Geology	20% (Working experience with Infratech Sdn.Bhd.)	Geological mapping Earth circulation process	Planning and managment
Shazrul bin Saruji	Civil Engineering (Construction)	25% (Fresh graduated)	Civil Engineeing software ESTEEM EARTH DRAINAGE 3.0	AutoCAD drawing
Mohd Fadzree bin Ismail	Civil Engineering (Structure)	20% (Working experience as site engineer)	Site Investigation Project Management	Decision making Inspection Time
Wira Jaya bin Jaidir	Environmental Engineering	50% (Working experience with contractor)	Laboratory analysis	Trouble shooting computer

3.3 Stakeholders

Stakeholders play a significant part in the success of this project. Tthe list of stakeholders for the projects as identified by the students are:

- Tok Batin (chief of tribe from the 4 villages)
- Local community
- Local authority
- Department of Orang Asli Development (JAKOA)
- Ministry of Rural and Regional Development
- Tourists

The Tok Batin is the point of contact of the project. The Tok Batin helped to coordinate much of the related activities and was responsible for introducing the students to the Orang Asli culture and heritage during the initiation stage. The local communities were directly involved in this project as a part of the team members and assisted all student groups in the process of gathering information and conducting the study. JAKOA is a governmental department responsible for helping the local Orang Asli communities in developing their economy, increasing social livelihood and conserving the traditional heritage. JAKOA was made one of the panel evaluators of the PBL project. The data and sustainable ideas for eco-tourism activities at POS Kuala Mu form part of the contribution of the students to JAKOA who may choose to implement or further refine the ideas in future.

3.4 Assessment

Three (3) major aspects on the development of eco-tourism in this area are sustainability in the environment, economy and social aspects. Table 2 summarises the issues identified, the criteria of assessment and the method of assessment.

During the initial stage of the project, students explore and experience first-hand the nature, natural resources, flora and fauna, activities, and the culture of the local Orang Asli in order to gather the relevant information needed. The students design the criteria of assessment and select the method of assessment using standard procedures with reference to existing literature reviews. Questionnaires were developed and interviews were conducted with the local communities, Tok Batin, visitors and

JAKOA representatives. The local communities, including the youth group, were very friendly and cooperative in the project. The local representative also learns about the method of assessment used for water quality, air quality and noise level assessment using the scientific equipment from the faculty.

Table 2. Issues identified, criteria and method of assessment

Identification	Criteria	Method of Assessment
Environment	● Natural resources ● Clean water ● Sanitation ● Solid waste ● Air quality ● Water quality ● Noise level ● Flora and fauna	● Water quality sampling and analysis ● Air quality sampling and analysis ● Questionnaire ● Observation
Social	● Quality Education ● Employment ● Skill ● Health ● Lifestyle	● Questionnaires ● Interview ● Existing report
Economy	● Income generation ● Occupation ● Mode of transportation ● Facility ● Power supply	● Questionnaires ● Interview ● Observation

3.5 Propose Solutions

Each group, led by a selected leader, is required to propose sustainable solutions. The solution could be for long term or short term. The idea must be either to improve the existing condition or to create a new one. Each group has to justify their proposal and present the idea to convince the panel. By conveying the solution of the project to the stakeholders, students are trained to communicate articulately with the public and to increase in confidence in presenting the solution provided. They are also required to gather the feedback from evaluators and improve the design for the final report. Some of the solutions provided b the students in the case study are shown in Table 3:

Table 3: Short term and long-term solutions for Pos Kuala Mu

Identification	Criteria	Solution
Environment	● Natural resources ● Clean water ● Sanitation ● Solid waste ● Air quality ● Water quality ● Noise level ● Flora and fauna	● Integrated and sustainable solid waste management including appropriate collection and storage system, composting for organic waste and waste recycle programme. ● Inventory of flora and fauna species

Identification	Criteria	Solution
		• Small sanitation treatment syatem to replace pour flush toilet and individual septic tank • UV treatment for drinking water
Social	• Quality Education • Employment • Skill • Health • Lifestyle	• Training for youth in business and marketing • Non formal education for self cleansing and sanitation • English class for tourist guide
Economy	• Income generation • Occupation • Mode of transportation • Facility • Power supply	• Website development and media social for promotion • Improve clean water, sanitation and solid waste disposal facilities • Mini hydropower and solar energy

3.6 Rubric of Assessment

Brookhart (2013) stated that the main purpose of rubrics is to assess performances. Some performance involves observation on the student in the process of doing something. Other performance involves observation of the end product of the students' work. The measured performance are important indicators of the learning outcomes. Rubrics are important because they clarify to students the expected quality of work to be produced.

In designing the rubric for the PBL activities, three (3) attributes were measured, namely communication, leadership and managerial ability, each of which are assessed by the facilitator or lecturer. The attributes emphasize on clear delivery of ideas, ability to understand and respond to questions, problem identification, impact analysis, generation of solutions, evaluation and selection of ideas/ solutions, reliability of solution, sustainability of project and the presentation itself. Table 4 shows the rubric for the assessment. In addition, the panelist and the local community are also involved in the evaluation of the poster presentation, which is ranked from very weak, weak, fair, good and very good.

Table 4. Attributes for communication

Attribute	Sub-attribute	Very weak (1)	Weak (2)	Fair (3)	Good (4)	Very good (5)
	Written Communi-cation	Not able to write and integrate existing ideas systematicall y	Able to write and integrate existing ideas, unable to provide new solution and require further improvements	Able to write and integrate existing ideas, able to provide new solution but require minor improvement	Able to write and integrate existing ideas and provide new solution clearly	Able to write and integrate existing ideas and provide new solution clearly

Attribute	Sub-attribute	Very weak (1)	Weak (2)	Fair (3)	Good (4)	Very good (5)
Communica-tion	Verbal Communi-cation	Not able to deliver ideas effectively	Able to deliver ideas with limited effect and require further improvements	Able to deliver ideas fairly effectively and require minor improvements	Able to deliver ideas effectively and articulately	Able to deliver ideas with great effect and articulate
Leadership	Effective leadership	No clear evidence of ability to lead self and/or others	Able to lead self and/or others towards goal achievement but limited effect and require further improvements	Able to lead self and/or others towards goal achievement with some effect and require minor improvements	Able to lead effectively self and/or others towards goal achievement	High ability to lead effectively self and/or others towards goal achievement
Managerial	Inquisitive Mind	No initiative to complete a task	Demonstrate limited initiative in completing a task	Demonstrate moderate initiative in completing a task	Demonstrate good initiative in completing a task	Demonstrate excellent initiative in completing a task

Average evaluation for overall impression about the course based on students' feedback online is shown in Table 5.

Table 5: Students' Feedback online

Overall impression about the course	**Average mark (/ 4.00)**
I have increased my knowledge from taking the course	3.63
The course content is related to my fied of study	3.57
The method of assessments in this course has enhance my learning ability	3.60
My confidence level in this course has increased	3.60

3.7 Achievement

There were two panels for each group. Panelists were appointed from JAKOA and representatives of the local community, which include the youth leaders and academic staff from the faculty. The total number of groups was six (6) and each group consisted of six (6) members. All groups were ranked from good to very good based on their performance in the project. In communication, the student mostly demonstrated the ability to write and integrate existing ideas and provide new solutions clearly. They were also able to deliver ideas clearly and articulate in verbal communication. Most of the students were able to lead effectively oneself and/or others towards achieving the goals and demonstrated excellent initiative in completing the tasks. Sharing information during the poster presentation was very success with excellent feedback from the panelists. As planned, the students hand over their report to JAKOA and the local community as a form of contribution.

4. Conclusion

This paper described the design and implementation of PBL in Sustainability Management course in FCE, UiTM. The PBL was successfully carried out and achieved the learning objectives as intended. The effort and idea of the students not only showed the students' knowledge and understanding, but also benefited the local community where the problem is based on. The students gained new experiences and became resourceful in addressing sustainability management. Feedback from the panels suggest that the rubric needs further improvement especially to address the criteria on ethical decision. It is recommended also that the attributes for teamwork and individual contribution be taken into considerations.

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