Application and Lesson Learned in Civil Engineering, Environmental Science Service-Learning Program

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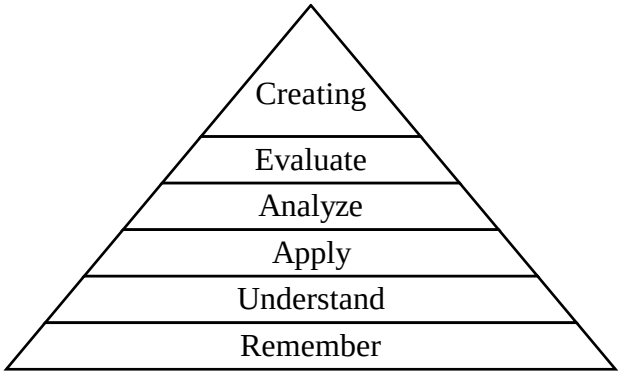
Abstract

Environmental Science class is an integral part of any modern 21st century Civil Engineering education curriculum. The rising need for sustainable development education in addition of education that does not only focus on the cognitive part but also the affective part required an evaluation of Environmental Science class curriculum. Petra Christian University began to apply Service-Learning style of education in its Environmental Science class since 2017, in order to fulfill the previously stated challenges. Reworks on class material and implementation of class-wide Service-Learning project was done. Putting student's creativity and autonomy at the forefront of the Service-Learning project, the class is considered as a success. The student-produced reflections and academic report that demonstrated their comprehension of sustainable development showed that the Service-Learning project managed to educate their heart. The Service-Learning based Environmental Science class can be used as a model and precedent for other Civil Engineering Departments that want to implement meaningful and impactful Environmental Science class.

1. Introduction

As part of the Civil Engineering Department curriculum, students of Petra Christian University (PCU) are enrolled in Environmental Science class (EnSci). The goal of the class as stated by the PCU CED syllabus is to make the students "capable of understanding the environment and the estimated impacts that will exist in the environment due to activities related to civil engineering practices". The class only contained lectures and focused on making the students remember basic ecosystem cycle and local regulation. Based on Krathwohl Modified Bloom's Taxonomy, the previous curriculum would sit on the lower level of taxonomy (Krathwohl, 2002).



Picture 1. Modified Bloom's Taxonomy

The recent change of the National Government of Indonesia's policy also presented a challenge for the class. Since 2015, the National Medium-Term Development Plan integrated the Sustainable Development Goals 2030 (SDG 2030) set by United Nation. And thus, in accordance with that, a revamp of the EnSci class to focus on sustainable development are designed. In accordance with pedagogical advance and considering the new student learning outcome that puts emphasis on Higher Order Thinking Skills (HOTS), it is decided that the new EnSci class will be based on Service-Learning and Creation level of Modified Bloom's Taxonomy.

Several systematical challenges arose in pursuit of those goals. The unique socio-economic development and environment of Indonesia require a vernacular approach to the Service-Learning project for the class to answer an important local issue. Beside the Service-Learning project itself, there are also logistical and organizational challenges. Answering these challenges would be a prerequisite in order to create a meaningful, local-based Service-Learning class.

2. Theoretical framework/literature review

General Overview

In accordance with *Tridharma*, Indonesian National Qualification Framework and higher learning process of Modified Bloom's Taxonomy, the new Service-Learning based EnSci class (Which will be called SL EnSci for the rest of this paper) has three main targets as part of its learning outcome. These targets are:

1. The students can comprehend ecological concept and the effects of civil engineering on it.
2. The students can comprehend a holistic sustainable development concept.
3. The students can implement sustainable development concept for identifying and solving development problems.

In addition to these main academic targets, several additional targets are also used for the class outcome. These targets are set considering the PCU Student Development Goals and The Delors Report 4 pillars of Learning. The additional goals are added because it is believed that education should not only affect the cognitive part of the students but also the affective part, in consistency with the Modified Bloom's taxonomy. It must be noted that the Service-Learning nature of the class makes the attainment of affective part of learning possible because the "Service" part of the Service-Learning allows education of the heart by the way of interaction with the local community. The above-mentioned additional targets are:

4. The students can implement Servant Leadership and LIGHT (Love, Integrity, Growth, Humility, and Truth) in their academic activities.
5. The students can actively participate in the nation-building process by learning to live together.

Considering these target, SL EnSci class is designed with a final, class-wide, Service-Learning community service project that improves the environmental condition of the chosen site in accordance with the SDG 2030 target. For the textbook, the previous textbook that put the focus on the environmental cycle and local regulations is not abandoned. This is due to the fact that these learning materials are essential for developing a sustainable development mindset. However, this does not mean that the previous material is used verbatim, but rather modernized

and condensed to adapt to the new SL EnSci class target, with several additions in order to fill the lack of several new materials that suit the learning outcome.

Table 1. Material Comparison between the previous and new EnSci class

EnSci Class Material	SL EnSci Class Material
1. Ecological Concept	1. Ecological Concept
2. Living Environment and Functional Relations	2. Living Environment, its Functional Relations and Global Issues.
3. Applications of Technology and its effect	3. Applications of Technology and its effect
4. Global Environmental Issues	4. Sustainable Development
5. Sustainable Development	5. Introduction to Environmental Impact Analysis
6. Policy of Environmental Development	6. Introduction to Kampung
7. Environmental Development Technology	7. Introduction to Service-Learning and Community Service with Class Discussion

While both the old and new Service-Learning based classes shared several topics, several changes are made. Sustainable development concept is put on the forefront. And thus, most of the class topics are viewed from sustainable development viewpoint. In this case, sustainable development is not limited to its ecological impact but also its economic and social aspects. This is the most critical part of the change. The expansion of the sustainable concept required engineers to not only look at the ecological impact of its future construction, but also the human impact. Aside from the fact that the United Nation Brundtland Commission defined sustainable development as that, the importance of considering the human impact can be demonstrated using simple illustration that is taught in the new SL EnSci class. In Indonesia, several high-rise projects received backlash from the local populace because the high-rise building blocked the local populace's TV signal. Thus, the project cannot be considered sustainable because the local populace opposed it publicly.

Picture 2. Guest Lecture by Local Health Practitioner

In the same vein as the previously mentioned example, the new SL EnSci class material focused on more concrete and realistic situation that will be faced by an engineer in Indonesia. For example, in SL EnSci class material number 3 (that is directly comparable to the old EnSci class material), the class discussed the contemporary topic about the effects of modern-day reclamation that happened in Jakarta, the capital of Indonesia.

The introduction to Kampung, in combination with the new study material for Sustainable Development, provides Indonesian specific views of sustainable development. In this vernacular material, the students are taught about the development problems that are facing Indonesian kampong. The specific material that is taught for subject 4 and 6 varies, in one semester the class invited PCU Institute for Research and Community Service Officer to provide background information, a medical doctor to taught about health aspect on sustainability, and how to socially adapt with the local populace.

In addition, due to the new nature of the class, the grading system that previously put emphasis on test (50% midterm and 50% final term) is changed. While midterm and final term still exist, the class wide community service project composed 65% of the student's final grade.

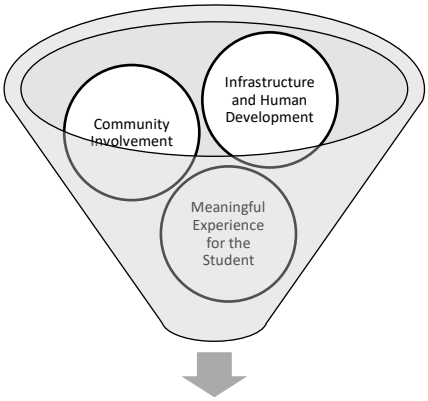
The evaluation for the class wide community service project are as below:

1. Student's active participation in the community service project.
2. Academic Paper and Presentation (Team based)
3. Student's Reflection

Service-Learning Community Service Project

Three guiding principle are used in developing the Service-Learning Community Service Project. These principles are:

1. Infrastructure and Human Development
2. Community Involvement
3. Meaningful Experience for the Students.



Picture 3. The Three Guiding Principle

These principles are established based on previous experience of community service held by PCU and other organization and pedagogical concept of Service-Learning. Keeping these three principles in mind, the SL EnSci Final class-wide project of applying sustainable development in community service is conceptualized by the student. The students are given freedom to choose where, what, and how they will do the final Service-Learning project. The student organized their own proposal, funding and permit for this project. This approach is used because it is hoped that the students do not only learn about sustainability, but also organizational skill and leadership.

Table 2. Modified Bloom's Taxonomy Table

The Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual Knowledge (Basic elements of knowledge)	*Classroom Seminar*	*Classroom Seminar*				
Conceptual Knowledge (Knowledge of interrelationship)				*Synthesis of Service-Learning Final Project Plan*	*Synthesis of Service-Learning Final Project Plan*	*Synthesis of Service-Learning Final Project Plan*
Procedural Knowledge (Methods of Application)			*Activity during Service-Learning Final Project*			
Metacognitive Knowledge (Knowledge of cognition in general and about self)			*Activity during Service-Learning Final Project*			*Leadership Activity during Service-Learning*

As shown in the table above (adapted from Krathwohl paper), if the Service-Learning project was predetermined from the start and the students are left as participant, the students would lack higher level of learning. Besides, it must be noted that without involving the students at all level of planning, the Service-Learning class would devolve into only 'service' class because the expected 'learning' process from the SL EnSci class comes when the students identify and create the sustainable development project. Involving students to act as a participant would not provide them the expected problem-solving and creation skill that is hoped from them as future engineers.

It must be noted that despite the students' academic and creative freedom for the final project, guidance is still given to ensure satisfactory result and desired learning outcome. Guidance is given especially during the synthesis phase of the final project. The students are guided and given assistance to conduct surveys in Putat Jaya kampong, former home of the Dolly prostitution. Aside from that, the planning of the project is left to the students.

3. Methods

Primary evaluation methods for the new SL EnSci class are based on the student's reflections and academic reports of their Service-Learning. Because the evaluation focus is on the Service-Learning and application, statistical analysis of Service-Learning effects on the exams result is not considered (because the written exam concerns with Factual Knowledge level that is not the main target of the Service-Learning Class).

Academic Report of the Service-Learning and Reflection

Despite being a class project, each student is still individually evaluated. Each of the student is evaluated based on their team of three-person's academic reports of their Service-Learning. It must be noted that due to the limited scope of the Service-Learning project, available topics for each team tends to overlap. The structure of the academic report is given below:

1. Introduction
2. Goals
3. Methods
    a. Pre-Implementation
    b. Implementation
    c. Post-Implementation
4. Result and Discussion
5. Summary

Table 3. Summary of Service-Learning Evaluation

Target	Evaluated With	Indicator
The students can comprehend ecological concept and the effects of civil engineering on it.	Academic Report of the Service-Learning	Students can correctly describe the problem that is facing the community due to construction or lack thereof.
The students can comprehend a holistic sustainable development concept.	Academic Report of the Service-Learning	Students can conceptualize or provide solutions to the previously mentioned problem.
The students can implement sustainable development concept for identifying and solving development problems.	Academic Report of the Service-Learning	Successful implementation of the student's problem solution.
The students can learn and implement Servant Leadership and LIGHT (Love, Integrity, Growth, Humility and Truth) in their academic activities.	Student's Reflection	Student's empathy to the subject of Service-Learning and willingness to initiate further solutions.
The students can actively participate in the nation-building process by learning to live together.	Student's Reflection	

In effect, these academic reports act as a Service-Learning journal that measured their comprehension of sustainable development. The students that have deep understanding of ecological concept and sustainable development are expected to provide more in-depth academic reports compared to the students that participate passively without learning in the Service-Learning.

Aside from the academic report, the students are also asked to write a reflection. These reflections are used to measure the non-cognitive part of the Service-Learning experience. In order to help the students to write a reflection that can truly reflect what they feel, the students are provided with question and description of what they should write in their reflection. The guidance provided to the student can be seen in Table 4.

Table 4. Student Reflection Guidance

FACTS	Describe and explain your experience before, during and after SL is done.	• What happened? • What kind of experience did you get? • What is the most memorable experience?
FEELING	Your feeling and emotion before, during and after Service Learning is done.	• How is your feeling? • What event that caught your attention? • What is or How is your expression during that event?
DISCOVERY	In discussion, reason and interpretation from your story, feeling and emotion.	• What was your main reason you have the previously mentioned feeling? • What did you learn? • Do you ever feel a similar experience?
FUTURE	How you will use the SL experience for your future life.	• What story (from SL) impacted your life most? • Hope for you future live? • What kind of lesson you learned for your future career

4. Results and Discussion

From the start of the new Service-Learning based Environmental Science class in 2017, several semesters of the class have been held. Most of the classes decided to do their Service-Learning project in Putat Jaya region. They decided to do so, aside from practical concern of familiarity, in order to benefit and build on top of the previous semester's Service-Learning project. In the last three years the class has built:

1. Colorful Kampung (*Kampung Warna-Warni)* and Clean Sanitation – 2017

Picture 4. Compilation of The First Service-Learning Class Project.

2. Smoking Area and Clean Sanitation – 2017

Picture 5. Compilation of The Second Service-Learning Class Project.

3. Catfish Cultivation – 2018

Picture 6. Compilation of The Third Service-Learning Class Project.

4. Colorful Garbage Can – 2018

Picture 7. Compilation of The Fourth Service-Learning Class Project.

Describing each of the semester final project in detail is out of scope of this paper because each of these project would fill an entire academic paper by itself. But a summary of the activities is provided bellow:

Table 5. Summary of the Service-Learning Class Projects

Year	Project	Description	Aspect
2017-1	Colorful Kampong	Painting the kampong streets with colorful color in order to improve the living quality. The activity was sponsored by Nippon Paint, local paint manufacturer.	Quality of Living / Ecological
	Sanitation Improvement	Building toilet to replace the existing non-sanitary toilet and providing the locals with handwashing and garbage disposal facility.	Quality of Living / Ecological
	Sanitation Education	Educating the local populace about how to wash hand properly in partnership with local STBM (Community Based Total Sanitation Program).	Quality of Living / Social Aspect
2017-2	Smoking Area Development	Building a Smoking Area in order to reduce the possible effect of second-hand smoke.	Quality of Living – Ecological
	Sanitation Education (2)	Continuing the education to the local populace about how to wash hand properly in partnership with local STBM (Community Based Total Sanitation Program).	Quality of Living / Social Aspect

Table 5. Summary of the Service-Learning Class Projects			
2018-1	Catfish Cultivation	Building Catfish fishpond for cultivation purpose	Economical Resource Improvement
2018-2	Colorful Garbage Can	Building a new, colorful garbage can.	Quality of Living – Ecological

In addition, it must be noted that:

1. The project is self-funded by the student activities. No funds are provided by the University. The students found sponsor for Service-Learning and did garage sale by themselves.
2. The Service-Learning project involves community involvement, such as the local *Rukun Tetangga* (Brotherhood of Neighborhood, or hamlet) and RW (Brotherhood of Citizen, or neighborhood) organization and other community-based organization. For example, in the first and second Service-Learning project, the class and the student partnered with the local STBM. The reason for the partnership is in order to ensure the sustainability of the sanitation project after the students left the site.
3. All of the Service-Learning projects also involve social activities with the local's children.
4. Several of the Service-Learning class projects done post-activities survey to the local populace. Survey result shown that most of the local populace feel benefited by the Service-Learning project. Request for future improvement for their communities are also recorded.

Picture 8. Social Activities during Service-Learning Projects

Analysis of the Student's Academic Report

As the result of their Service-Learning project, the students created an academic report of their Service-Learning activity. Several of the student's reports are available online in PCU "Petra Community Service" Repository (In Bahasa Indonesia). Because the subjectivity of the academic report review and grading process, qualitative analysis of the selected students' academic reports are provided below:

1. Students can articulate the main problem that are faced by the communities (Hermawan, Setiawan, William, & Sumarno, 2018) (Harsono, Yuki, Wibowo, & Hermawan, 2018).
2. Students can precisely record their Service-Learning activities in detail (Hermawan, Prayogo, & Prayogo, 2018).
3. Students can critically create, implement and argue for their sustainable development solution for the Service-Learning project (Harsono, Yuki, Wibowo, & Hermawan, 2018).

Several of the selected students' academic records are sent to the Indonesia National Ministry of Research, Technology and Higher Education to qualify for PKM-AI (*Program Kreativitas Mahasiswa – Artikel Ilmiah* / Student Creativity Program – Scientific Article). In 2018, one of student team won the PKM-AI grant incentive, proving that the quality of the student's submitted academic report is good enough for publication outside PCU.

Analysis of the Student's Reflection

Beside the academic reports, the student reflection is one of the most important tools to measure the success of the Service-Learning implementation. From the student reflection it is hoped that the student can learn 'heart-changing' experience and at the same time, taking lesson for their future career in the field. Several of the student reflection (translated) are shown below

Subject C5-1

"At the end of the event, I received many wisdom and lessons that I found very meaningful. Even though most of the local populace lives in average economic condition, most of them are willing to provide food for the working students. It taught me that material poverty does not make a person poor-hearted. If we had been helped by other people, we can repay that help with whatever we have"

Subject A1-1

"This is a very important lesson that I will never forget. They taught us to give thanks for whatever material possessions I already have. Even though I only have modest material possessions, I am committed to give the best. I want to live to be a blessing for many other people, not for my own ego. Watching their smile makes me smile too. This is what I dreamed when I become successful. I wanted to share my success with those in need. Because happiness is achieved when we share"

Subject A2-2

"In 6th May of 2017, I come back to Putat Jaya Village in order to paint the local's houses. Mr. Hermawan shown us the houses that is my team responsibility to paint. At first, my team thought that the job allocation was not fair, because one of the houses that we must paint required substantial amount of painting. But at the end, I realized that complaining would not do any effects and only waste time, I realized that with the greater responsibility (of painting) given to me, I am given greater opportunity to help the people of Putat Jaya. Aside of that, I also realized that SL would be a practice for me to prepare for my future participation in the workforce."

Subject A3-3

"I feel very well received and accepted despite feeling it is not easy to be at an environment filled with people who are clearly different from me. Based on experience and hear say, in today ages, the differences between races are very extreme. Some people do not even want to talk to people that are racially different. But with the Service-Learning activity I learned that not all people are like that. That not all people have the same mindset and that people of the same race does not always have the same opinion. It is not my first time to be in a situation like this, because I considered myself as easy-going, but with this event, I become more convinced that not all people are the same with what I thought. I am happy that I can exchange mind with them, because for me they can teach me the real meaning of life, teaching the meaning of brotherhood"

In general, the reflections of the students show that the participants consistently developed a better understanding of kampong. Previously, it must be noted that most students do not understand the living reality in Kampong and often believe in the existing stereotype. Because of the interaction that happened during the Service-Learning, the students developed a better understanding and a better sense of civic participation in Indonesia. Based on the same reflections, most student also realized the privileged situation they lived, compared to the local populace. As the result, they feel more encouraged to share what they already have.

In summary, it achieved the main goal of character development that is set previously, that the students can learn and act the values of LIGHT and Servant Leadership. However, tertiary target that the student is able learn and value practical engineering/construction skill that is outside the scope of Environmental Science but are still inside the scope of Civil Engineering (concrete pouring, wood cutting, painting etc.) is not achieved. Most of the student does not write or put any emphasis on the practical construction skill.

5. Conclusions and contributions to theory and practice

The new Service-Learning based environmental science class is considered as a success since it managed to achieve its main goal of creating a local based Service-Learning curriculum and, at the same time, achieved higher level of learning that was previously not possible. Because of the success of the Service-Learning, we consider that the practice implemented in the class could be used as a model for further Service-Learning project in other Civil Engineering class. We believe that the model we used has shown real results, both for the students and the community. Further enhancement of the model is also recommended. One of the recommendations we propose is integrating the Service-Learning with other department's Service-Learning classes in order to create a more comprehensive service project and increase the student's apprehension of the multi-knowledge-field world today.

Keywords: environmental science, Kampong, service learning, sustainable

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