The Implementation of Photovoltaic Academic Service Learning at School and Its Impact on Student Schools and Student Facilitators

Article history
Received
9 November 2022
Received in revised form
15 December 2022
Accepted
15 December 2022
Published online
20 December 2022

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Abstract
This paper presents the implementation of academic service learning (ASL) and its impact on secondary school students as the community and the university undergraduate students who act as facilitators. The facilitators are the final year students from the Faculty of Electrical Engineering undertaking a photovoltaic technology course at Universiti Teknologi Malaysia. The ASL aims to transfer the knowledge of photovoltaic technology to the school student from the university's students and increase their interest in pursuing tertiary study in the science, technology, and mathematics (STEM) stream. At the same time, it will benefit the facilitators by enriching their communication skills, personality, and academics. The objective achievement of the activity is measured qualitatively through a set of questionnaires after the activity. It was found that ASL has positively impacted the school student's knowledge of photovoltaic technology. To measure the impact on the facilitator, questionnaires were given to them after a year of graduation. The majority of them agreed that ASL improved their communication skills and personality. However, most facilitators agreed that ASL has minimum impact on enhancing their knowledge of photovoltaics.

Keywords: academic service-learning; photovoltaic; secondary school students; university.

Introduction

There are three educational learning theories: behaviorism, cognitivism, and constructivism. Behaviorism is a theory based on routines that "drill" information into a student's memory bank and positive feedback from teachers and an educational institution (Rodríguez-Izquierdo, 2020). The theorem is only concerned with observable stimulus-response behaviors. On the contrary, cognitivism moves away from behaviorism and focuses on the mind's role in learning instead. Learning relies on external factors (like information or data) and the internal thought process. The constructivism theorem is more on the active engagement of the learners towards its surrounding, i.e., community. The learner builds upon their previous experience and understanding to construct a new understanding.

Academic service learning (ASL) is an educational approach categorized under the constructivism theorem (Buntat et al., 2013). It combines classroom instruction with real-world experience. Students learn academic concepts and theories while gaining practical skills and knowledge through service projects. Service learning can take many forms, but all programs share a common goal - to provide students with opportunities to apply what they are learning in the classroom to real-world situations.

This hands-on approach helps students develop a deeper understanding of course material and how it can be used in the real world. Service-learning projects can be designed to meet any community's needs and be structured to fit the available time and resources. Programs can range from a one-time project to an ongoing commitment involving individuals or groups of students. No matter what form it takes, ASL provides students with valuable experience that can help them in their future studies and careers (Friman, 2017).

In line with that, the National Education Development Plan 2015-2025 (for High Education) highlighted the necessity of deploying a service-learning approach that combines experience-based education and entrepreneurship into the university's curriculum. For that, Service Learning Malaysia (SULAM) initiative is launched (Ministry of Education Malaysia, 2019). The objectives of SULAM are:

a. To increase student learning by combining both theory and community services.
b. To enhance the personality and civic of the student.
c. To fulfill the community needs using the theory learned by the students.
d. To build a conducive teaching and learning environment between lecturer, student, and community.
e. To give opportunities for NGOs to run and provide corporate social responsibility (CSR)

Under SULAM, various programs involving universities-community projects have been conducted. At Universiti Malaysia Sarawak (UNIMAS), a project

named Waste Separation Workshop with Kota Samarahan City Council (MPKS), Worming Up, and Farley Supermarket was held. In Universiti Teknologi Malaysia, a landscape project with Flat Taman Plentong Utama residents was carried out in 2015. This project involved the re-design of an unattended flat courtyard with an edible garden concept (Ministry of Education Malaysia, 2019).

This paper will present the implementation of Photovoltaic Academic Service Learning for secondary schools. Firstly, the outline of the Photovoltaic Technology course will be briefly described. The assessment method of ASL will be presented and discussed. Lastly, the outcome of the survey questionnaire on the ASL effectiveness in promoting Science, Technology, and Mathematics (STEM) among secondary schools is discussed. In addition, results from the survey to qualitatively analyze the ASL activity towards the civic, academics, and communication of the facilitators after they graduated will be presented.

Literature Review

It has been reported that the number of students studying science, technology, engineering, and mathematics (STEM) is falling by 6,000 annually (Malik, 2019). According to Akademi Sains, Malaysia's Science and Technology Human Capital Report and Science Outlook 2015, the country needs at least 270,000 science students annually to take the Sijil Pelajaran Malaysia exam. However, only around 90,000 are left (Nasa and Anwar, 2016). The number is quite worrying, and educators have urged the government to step up efforts to promote STEM interest among students to achieve the 60:40 ratio between STEM and non-STEM students (Zainudin et al., 2015).

In line with the effort, the Faculty of Electrical Engineering, Universiti Teknologi Malaysia, in 2017, introduced an academic service-learning (ASL) element in several school courses. The introduction of ASL is concurrent with the vision of UTM to strengthen public-university ties (Omar, 2018). In this course, the students must conduct knowledge transfer activities with the public. Apart from that, service learning will benefit the students, namely personality growth, civic learning, and academic enhancement. The relationship between the content of service learning and the goal is illustrated in Figure 1.

Photovoltaic Technology is an elective course in the Bachelor of Electrical Engineering at Universiti Teknologi Malaysia. In this course, the students are exposed to the technology of photovoltaic systems. The content covers solar panel materials technology, wind turbine, conversion system, energy storage system, and the direction of recent research in both energy technologies.

There is no specific guideline on the ASL implementation, credit hours, academic load, or assessment method for ASL courses (Ministry of Education Malaysia, 2019). Based on the literature, the assessment tools for ASL can be in the form of interview conduct, documentary, training module, portfolio, peer observation, exhibition, reflection journal, product design, and pitching session. It must be highlighted that the implementation of ASL and its assessment must be suitable with the course materials.

Based on that, the course will have an assessment: 50% from the final exam, 20% from the test, and 30% from the academic service-learning (ASL) activity. Out of the ASL assessment mark, 25% will come from the ASL activity, 15% from the ASL report, and 5% from the peer review assessment.

Methodology

In the academic session 2018/2019 semester 1, 57 students took this course and were grouped into five groups containing around 10 to 11 members. Firstly, each group is requested to identify potential secondary schools and communicate with the principal or counsellor. For this cycle, five secondary schools were approached, and they are:

a. SMK Taman Impian Emas
b. SMK Bandar Baru Uda
c. SMK Bandar Selesa Jaya
d. SMK Taman Pulai Perdana
e. SMK Taman Universiti 2

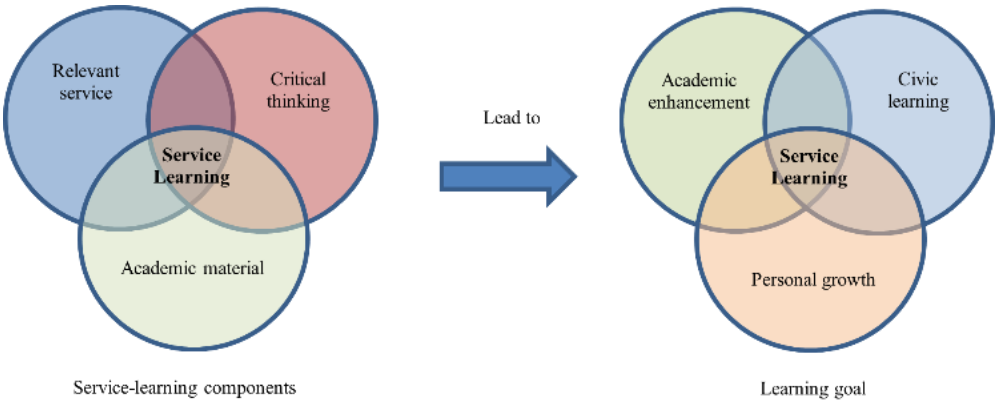
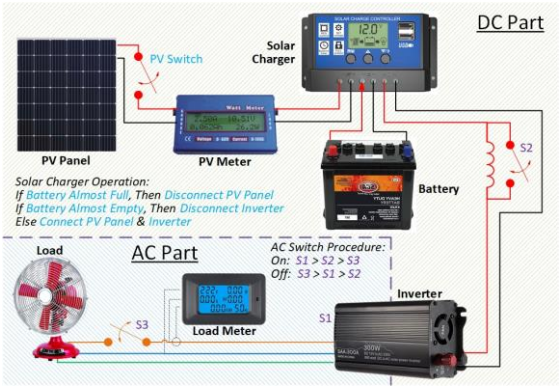


Figure 1. The component of service-learning and its learning goal

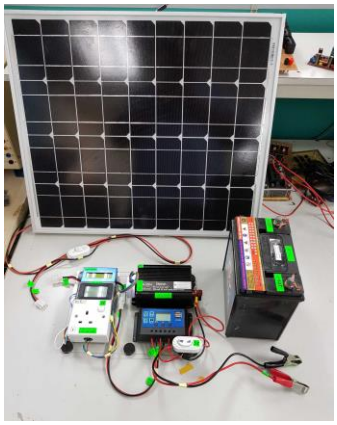
The groups came out with their proposal, which was discussed with the lecturer. The groups need to have two compulsory components in their activity. The first should be the 1-hour academic talk about photovoltaics and the second component is the 2-hour interactive activities. For the activities, students are compulsory to conduct a demonstration of the PV system. For this, a set of PV education kits was built for the demonstration, as shown in Figure 2. The PV education kit comprises of:

a. Solar panel Monocrystalline 20 Watt
b. PV meter and Load meter
c. Solar charge controller (PWM based)
d. 50-Watt Inverter
e. 240Vrms socket plug to connect an ac load
f. Lead-acid battery

The proposal will be assessed based on the talk's content and activities. All the activities development tool cost is limited to only RM200.00 per group. At the end of the ASL, each group will write a report on the activities that have been conducted. The mark of ASL activity will be 30% of their final mark. The breakdown of the marks is planning (5%), execution (20%), and Peer Review (5%). Figure 3 shows the interactive activities of the student. For the report preparation, all groups must design the report using a magazine template presentation style. Figure 4 shows the submitted report.



(a)



(b)

Figure 2. (a) The schematic diagram of the PV education kit, (b) The actual PV education kit

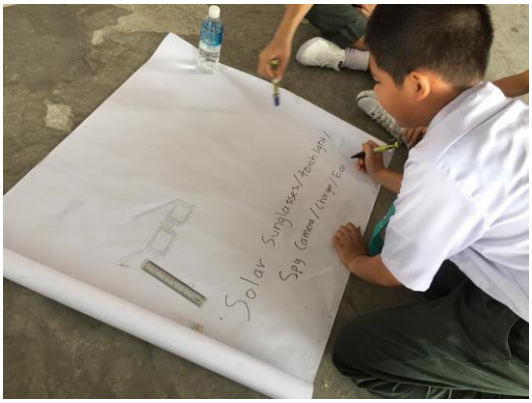


Figure 3. One of the interactive activities conducted in the ASL activity

Figure 4. Snapshot of reports on the ASL activities prepared by each group

Findings and Discussion

More than 200 feedback responses from school students were taken to evaluate the effectiveness of the activities in promoting STEM interest among the school students. Figure 5 is the chart that shows the percentage of students who have been exposed to photovoltaic technology. About 72% (blue coloured) of them have been exposed to this technology, while almost 28% did not have any exposure to PV technology at all. It is a worrying figure when considering the science textbook syllabus and internet infrastructure, where the information of photovoltaic can be easily accessed.

Figure 5. Chart showing the percentage of the student with PV knowledge exposure

Figure 6 shows a pie chart on the distribution of students who have high (blue coloured), medium (orange coloured), low (red coloured), zero level of knowledge (green coloured) on the photovoltaic technology. Comparing both Figures 5 and 6, out of 28% (Figure 5) who have no exposure on photovoltaic technology, only half of them have zero knowledge (Figure 6) on photovoltaic technology.

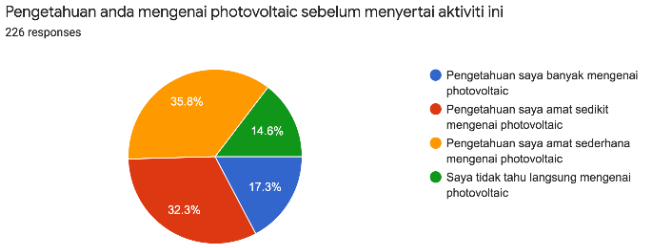


Figure 6. Chart showing the percentage of the knowledge level of the student with PV knowledge

Figure 7 shows the percentage of students who have gained knowledge of PV technology after the activity. Most of them agreed that the ASL activities had boosted their knowledge of PV technology. Only 1.8% (purple coloured - 4 respondents) said they had not benefited from the activity.

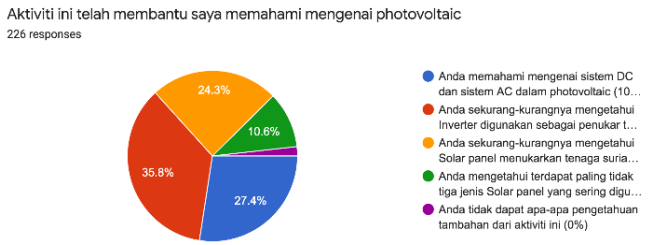


Figure 7. Chart showing the percentage of the knowledge level of the student with PV knowledge

As previously stated, the activity also aims to promote the school student's interest in STEM fields for the tertiary education. Figure 8 shows the result of the outcome. From the result, it is clearly shown that more than 87.6% of the students have an interest increment in pursuing STEM. However, there is 12.4% not interested to proceed with STEM fields. Several of the comments stated that they enjoy science and engineering but are worried about their ability. There were also feedback comments that their family barred them from pursue in STEM stream due to several unknown reasons.

Figure 8. Chart showing the percentage of students who will pursue in STEM stream

The outcome of ASL on civic, academic, and communication enhancement towards the facilitators is shown in Figure 9. Please note that the survey was conducted one year after they graduated from the program. Out of 57 candidates, however, only 50 respondents replied. None of the survey respondents continue their studies at the Masters or Ph.D. level. From the survey, most of them are already employed by governments and private sectors.

From the survey, it was shown that 100% respondents agreed that ASL has high impact in their communication skills. This is evident since they are responsible for approaching the school administration, which involves many discussions and occasional meetings to conduct the activity in the school. They learn how to communicate effectively with different level of school administrators. About 76% of the respondent agreed that ASL moderately enhances their personality. Some comments stated that they are more confident in managing a group task, working as a team, and responding effectively under pressure. Lastly, the academic enhancement is quite moderate. The distribution is quite equal. Some comments stated that the PV education kit that the lecturers develop is too technical for them to comprehend. Most respondents stated that it might be more beneficial if they were tasked to develop the PV education kit. By doing this, the learning process will be more effective.

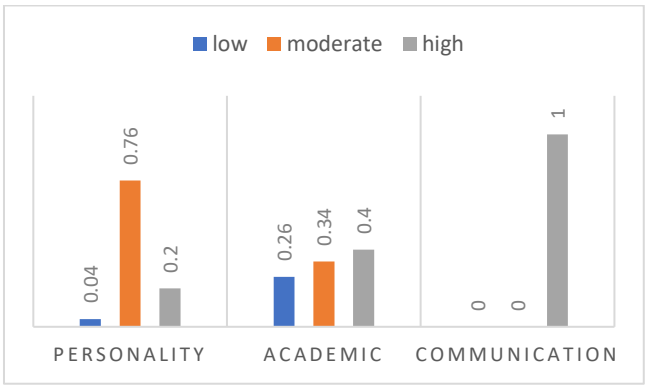


Figure 9. Summary of survey outcome based on personality, academic, and communication enhancement

Conclusion

This paper presents the implementation of photovoltaic academic service learning (ASL) and its impact on secondary school students and the facilitators. About five secondary schools with 200 pupils have benefited from the activity. The activity involves a 1-hour talk on PV technology by the students. Then it continued with a demonstration of PV technology using a self-developed PV education kit and interactive activities. From the feedback, it was found that the activity has increased their knowledge of photovoltaic technology and increased their interest in pursuing STEM education in the future.

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