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Improving Students' Understanding of Energy Conservation through Training on Making Electrochemical Storage Devices

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Abstrak Minimnya minat siswa untuk belajar IPA membuat program pembelajaran menjadi gagal. Salah satu cara untuk membuat pembelajaran menjadi menarik dan kreatif adalah dengan menggunakan benda-benda sederhana di sekitar dan mempraktikkannya. Kegiatan ini bertujuan untuk memberikan ide kepada guru untuk mengembangkan bahan ajar terkait alat penyimpan energi; dan memberikan pengetahuan tentang konservasi energi dan energi terbarukan, pemanfaatan biomassa, dan konsep dasar dalam pembuatan alat penyimpan energi. Kami menggunakan metode demo dan pelatihan untuk menyampaikan rencana program. Penilaian menunjukkan bahwa program ini mendapat respon positif dari siswa dan guru; topiknya sangat terkait dengan tujuan pendidikan, terutama untuk praktikum. Ada beberapa poin untuk merekomendasikan kegiatan ke depan yang berhubungan dengan topik tersebut, yang intinya adalah untuk berkolaborasi dengan lembaga lain, seperti universitas dan industri.

Abstract The lack of student interest in learning science makes the learning program fail. One way to make learning interesting and creative is to use simple objects around and bring them into practice. The aims of this activity are to provide ideas for teachers to develop teaching materials related to energy storage devices; and provide knowledge about energy conservation and renewable energy, the utilization of biomass, and basic concepts in the manufacture of energy storage devices. We use demo and training methods to deliver the program plans. The assessment showed that the program hasS been received a positive response from the students and teachers; the topic was strongly related to educational purposes, especially for the labwork. There some points to recommend future activities dealing with the topic, which in essence is to collaborate with other agencies, such as universities and industry.

Keywords: renewable energy; practice; learning science, electrochemistry

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INTRODUCTION

Science is the basis of current technological developments and forming human resources (Susilo et al., 2018). Science labwork specifically can be one of the driving forces for the growth of the will, desire, and awareness of students' abilities in their respective fields of specialization (Oktaviyanthi et al., 2017). The lack of facilities and infrastructure to support the implementation of labwork is the primary reason for the low interest and talent in sciences (Bukhari et al., 2019). This problem can be overcome by implementing a more attractive, contextual, and innovative learning process.

One way to make exciting and creative learning, is by utilizing simple objects that can be found around neighborhood easily and considered as a way to participate in the conservation energy movement (Puspadi et al., 2016). The program in Pengabdian pada Masyarakat (community service) share a topic that can be utilized as topic in science labwork. The topic is closely related to the results of several years of research conducted as a step for dissemination to high school (Sinaga et al., 2021). The proposed activity is specifically carried out to provide knowledge about the basic understanding, technology and process of energy storage. The use of local resources can be make positive opinions about the existence of energy storage and biomass supporting the technology (Rohita et al., 2021).

The team employ conductive carbon binchotan (Syarif et al., 2020) in making energy storage, especially batteries and supercapacitors. The precursor for the carbon is gelam wood bark carbon (Syarif et al., 2019). The introduction of energy storage in some learning topics in schools has been dominated by fossil energy, so students do not know many batteries or supercapacitors they see daily. Teachers are also less introduced to the energy storage's baseline, work principle, and technology. Electrochemical energy storage supports the development and application of renewable new energy. This description is essential, and this topic is to be taught to students.

The activities were devided into three sections, i.e., the presentation, demo of making simple energy storage and discussion. An evaluation or assessment is carried out to help the success rate of this activity, namely by discussion and question and answer with students/teachers, evaluating the student/teacher's interest in the event, and the review directly to the field after intermittent time. This community service program specifically carried out for student and teacher aimed to The aims of this activity, are to provide ideas for teachers to develop teaching materials related to energy storage devices; and provide knowledge about energy conservation and renewable energy, the utilization of biomass, and basic concepts in the manufacture of energy storage devices.

The expected benefits of this activity are: (1) for the team, the feedback from students and teacher suggestion, recommendation and idea for future our community service program; (2) for our student, the activities give experience dealing with society and to implement plans related to a program; (3) for our university, Universitas Sriwijaya, especially the Faculty of Mathematics and Natural Sciences and the Center for Excellence in Fuelcell Research are increasingly recognized as institutions that are concerned with community problems, education in secondary schools and the progress of the nation.

METHOD

Time and venue of activities

The team prepared materials and tools in our lab in Universitas Sriwijaya. The main activities were concentrated at SMAN 4 Lubuk Linggau, Sumatera Selatan. The participants of the activity are teachers and 30 students. The activity was carried out for two days from 17 to 18 October 2020 located in one of the classrooms at the school. The activities carried out included presentation followed by demonstrations.

Preparation for Main Activites

The methods were presentation and demos, briefly break into sections, i.e., materials preparation to make supercapacitors and batteries, electrodes preparation and making the devices. The presentations were delivered with video, questions and answers.

The preparation of the supercapacitor is as follows. The supercapacitor is made with a cathode - electrolyte/limiting - anode arrangement. The cathode and anode use the same material, namely a conductive charcoal/carbon chunks (Figure 1). One can select conductive carbon chunks from charcoal or conductive carbonl. A mini circular electric saw a polished slab of activated carbon/charcoal into monolith 3 cm x 2 cm^2 and a 3-5 mm thickness. The electrode surface needs to be leveled and smoothed with SiC paper P200 and P2000 before being used on supercapacitors. In the middle is a solid electrolyte in paper glue, PVA (polyvinyl alcohol), which contains table salt (sodium chloride). The solid electrolyte is applied to one of the electrodes and allowed for 3-5 minutes to have semi-dry consistence. Once the electrolyte has dried, it is ready to be attached to other electrodes.

(a) (b)

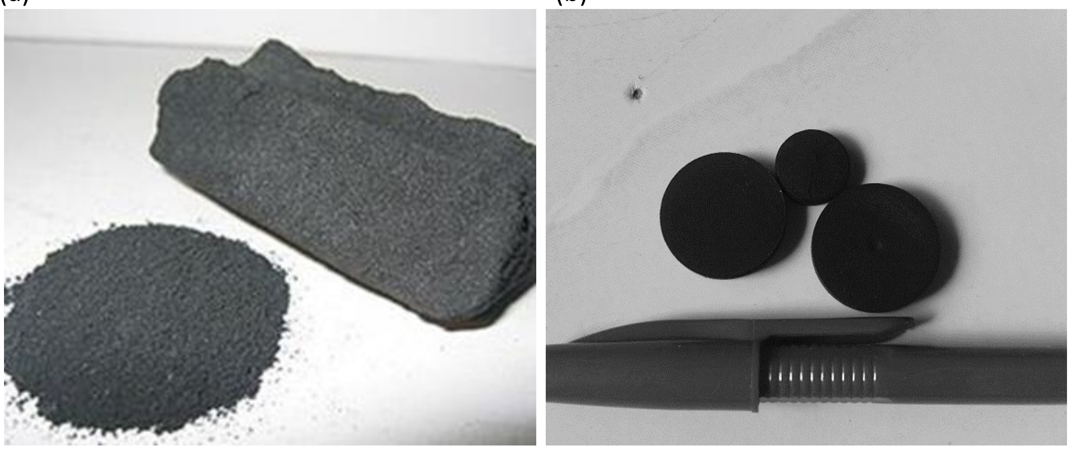

Figure 1. (a) chunk of carbon/charcoal and (b) the electrode for supercapacitor preparation

The preparation of the supercapacitor (Figure 1) is as follows. The supercapacitor is made of a cathode - electrolyte/seprator - anode arrangement. Both cathode and anode use the same material, namely a conductive charcoal/carbon. One can select conductive carbon chunks from charcoal or conductive charcoal. A mini circular electric saw a polished the chunks into 3 cm x 2 cm^2 monoliths with a 3-5 mm thickness. The monolith needs to be leveled and smoothed with SiC paper P200 and P2000 before being used as electrode on capacitors. In the middle is a solid electrolyte in paper glue, PVA (polyvinyl alcohol), which contains table salt (sodium chloride). The solid electrolyte is applied to one of the electrodes and waited for 5 minutes to semi-dry. Once the electrolyte has dried, it is ready to be attached to other electrodes.

The preparation steps for aluminum/copper batteries were proceed as follow. Copper wire with a diameter of 1.5 mm is formed in a spiral with a length adjusting the length/height of the aluminum tube (Figure 2a). The thickness of the aluminum plate used is 0.2 cm or 2 mm. One can use aluminum canisters with soda cans removed from the top and bottom or formed from 1-thick aluminum wire of varying lengths. At the bottom of the tube, a cap is made of non-conductive material, such as sandal rubber, acrylic, and used tire rubber. The hat is fixed with rubber or silicone glue and dried, covered/wrapped in a paper roll. Paper is the barrier between copper and aluminum. A coil of copper wire and paper is inserted into an aluminum tube (Figure 2b). Cleaned and dripped sand with sodium chloride solution (electrolyte) were added in the middle of tube until whole sand is soaked. Tire rubber covers the top of the aluminum tube, filled with copper wire spirals, and is then covered again with an acrylic plate. The copper wire from the inside is penetrated to the outside through the top tube cover holes. At least five batteries can be assembled in series to start a mini electric motor. Scales are used to measure the weight of the salt used. The salt used is 10-50 grams. The measuring cup is used to measure the water used, while the water used for the salt solution is 50 250 ml. The power supply is used to charge the saltwater battery cells. The power supply used is 24V 15A.

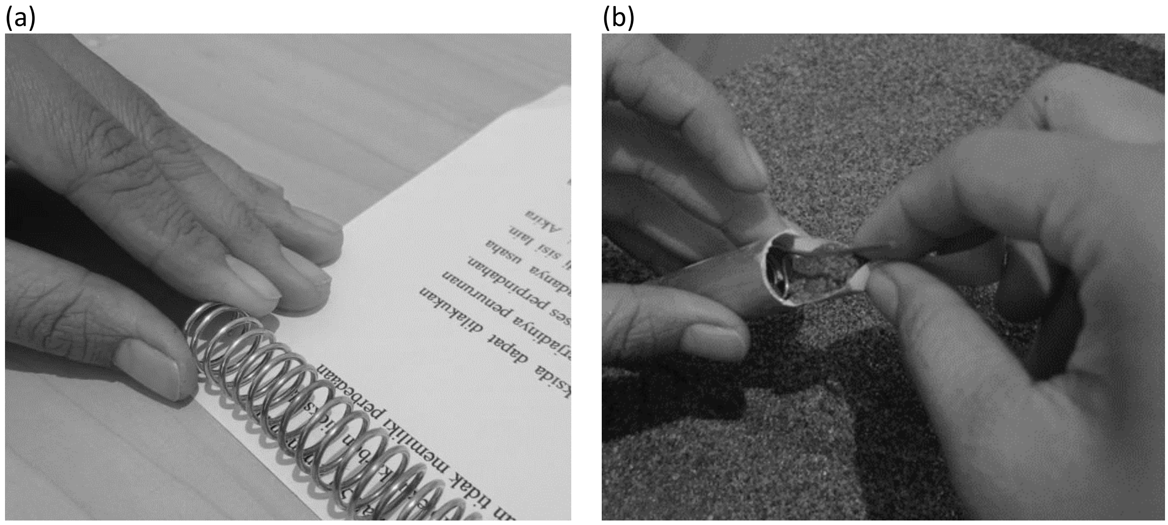

Figure 2. Preparation ofAl-Cu battery (a) copper wire and a piece paper as separator (b) cathode – separator – anode arranggement in battery

The main activities were conducted in the school with attending by teacher and student. Briefly, the main activites were opening and introduction to the participants i.e., students, and teachers, training on supercapacitors and batteries with a demo and presentation discussion/question-and-answer session with participants, group photo with counselling participants session.

RESULT AND ACHIEVEMENT

Preparation

Paperworks were prepared out together with other team members, such as making permission letters, cover letters from the dean, presentation materials and preparing samples for the demos.

A permission letter was submitted to the principal to implement activities and to parents/guardians of students who participate in the program activities. A dean's cover letter is used to carry out the team's duties to carry out activities. Permission letter addressed to the dean for the chairman and team members to leave campus activities while carrying out activities in the program.

(a) (b)

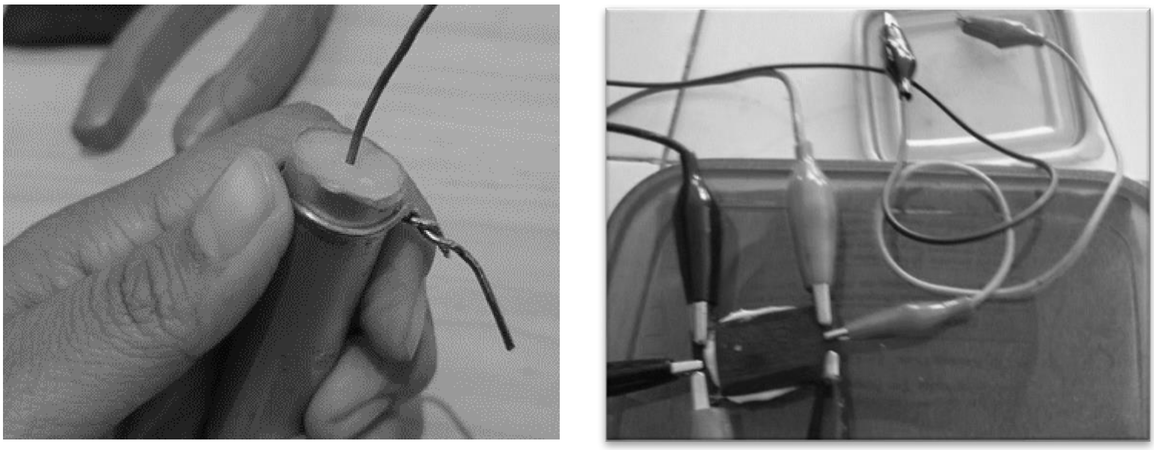

Figure 3. Simple energy storage devices (a) battery Al – Cu (b) Supercapacitor using two binchotan carbon electrodes

Slides and banners for activities and demo are prepared with attention to the detail, making that are easy to understand. The preparations of the supercapacitor and battery were brought out from our lab as well as tools and materials. It used minimum requirements as shown in Figure 3, following the design for school labwork. In addition to the physical, supercapacitors and batteries are made to function correctly by the central concept of energy storage devices, the devices power a minimum of electronic devices, such as LED lights or simple propellers. We also managed charging-discharging (recharged) device to supply energy to the storages.

Figure 4. Students and teacher followed presentation and demo in the program

Main Activities

The activities were conducted in a classroom and teacher's room with no wall making the two rooms into one hall. The school provides electricity to power the computer, infocus, power supply. Tables for placing materials and teaching aids were prepared by the school from several classroom tables, which were assembled into long tables so that they could be used as workbenches in making supercapacitors and batteries as well as testing the function of these two devices in the process of charging and discharging the charge.

We train some students, and teachers in order to make they experience in preparing the devices. The interactivity make students feel happy to learn so they can generate positive emotions in the learning process (Sobiruddin et al., 2020). A total of ten teachers and twenty students were involved in this activity, and the students were from third grade. Figure 4 shows the student, teacher and audiens attending the demo and presentation sections. The activities regarding supercapacitors and battery were carried out through the following stages.

Figure 5. Slide and banners in the class to help students and teacher understanding the topic

Activities regarding the preparation of supercapacitors and battery at school generally went smoothly. School administrators help prepare places, tools, and banner and coordinate counseling participants. The demo desk is very helpful in working with the tools and explaining the slides. The situations can be shown in Figure 5.

Before conducting the activities, the team introduced themselves first and then tried to explore basic knowledges (Sholahudin, 2017). The team asked several questions regarding the meaning of supercapacitor and battery and their relation to labwork in school and the use of related instruments in school, followed by explaining supercapacitor and battery and their relation to labwork in school and the use of related instruments. So that participants are enthusiastic and pay attention to the contents of the demo dan training materials.

The delivering of topic material lasted for approximately four hours. At the end of the session, the presenters provided the opportunity for participants to ask questions related to the material presented in slides and banner. Figure 6 show the situation of the demo and training. Several questions were received from the students and teachers regarding the material's content. After answering questions from participants, the team evaluate the provision of material that has been delivered by asking questions and providing opportunities for participants to answer these questions. The activity was closed with a group photo of audiences participating in the program. The activities were carried out well. The participants seemed enthusiastic as shown in Figure 6.

Figure 6. Anthusiasm of teachers in topic of the program, followed by trying the preparation and application process

The teacher hoped that the extension activities could continue with the provision of other materials, primarily related to the activities carried out, including counseling about supercapacitors, batteries, and potentiostat measuring devices accompanied by demo of preparing and their relationship with practice at school. Figure 7 show charging the supercapacitor and battery in power supply. School administrators also hope that there will be ongoing activities to increase the knowledge of teachers and students (Nurzali, 2019).

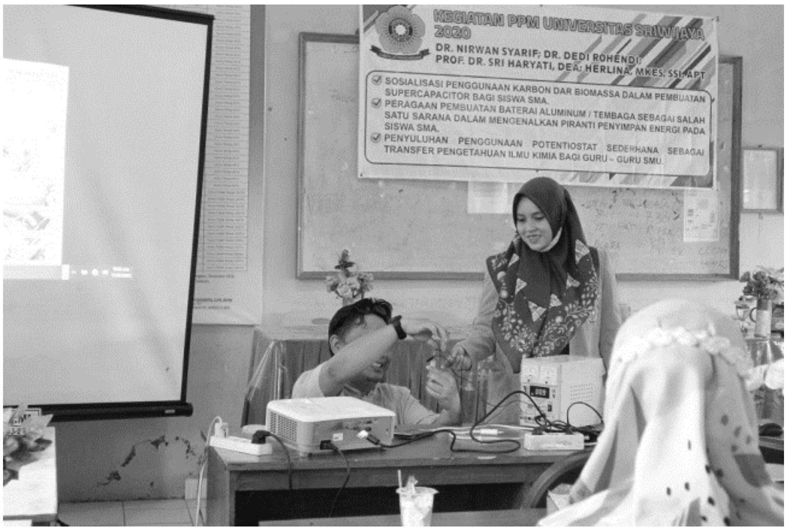

Figure 7. Demo of preparing supercapacitor/ and battery and applying the device in LED

The Assessments

The participants have learned and obtained some knowledges about the topic delivered by the team. We measured responses of student and teacher to the activities using a 4-point Likert scale (i.e. 1 = disagree, 2 = disagree, 3 = agree, and 4 = strongly agree) (Imaningsih et al., 2022). Students understand the material's content and were given non-trivial question and questionnaire at the end of the session. The results of the responses of participants satisfactory are presented in Table 1.

Table 1. Level of participants satisfactory on of the topic

Statements	Responses				Total	Mean
	Don't agree	Disagree	Agree	Strongly agree		
The activities providing knowledge about the energy in supporting the material for teaching physics and chemistry in high school.	0	0	10	20	30	3.67
The topics can be developed as chemistry/physics labwork topics in high school.	0	0	9	21	30	3.70
The activities provide knowledge of basic concepts and technologies that can be applied in the making of energy storage devices	0	0	15	15	30	3.50
The materials and tools used can be easily obtained If it is developed as an labwork topic,.	0	0	5	25	30	3.83
Students gain new knowledge about energy conservation after listening to the team's explanation	0	0	18	12	30	3.40
Students can understand that the biomass (natural materials) is a supporting material to ensure sustainability and conservation of energy	0	0	12	18	30	3.60
The activities carried out by Universitas Sriwijaya through the program is beneficial for you	0	0	15	15	30	3.50
The activities carried out by Universitas Sriwijaya through the program has met the target of educational	0	0	10	20	30	3.67

Mean values in Table 1 suggest that the topic was strongly related to educational purposes and the utilization of biomass in supporting the material for the labwork in high school. Most of participants were agree about the topic energy conservation and sustainable energy. This awareness has become an essential in science education (Nursaadah et al., 2022).

It can be seen from the data that the topic has usefullness in educational with participants satisfactory level of agree (> 3.5 of 4). Participants seem to pay less attention to the theoretical aspects even though they are still at the "agree" satisfaction level (3.4 of 4). The participants agreee that the team has provide basic concepts and technologies that can be applied in the making of energy storage devices. The data shows that as a whole the program has received a positive response from the students and teachers present, which is shown from the satisfaction level of 3.40 - 3.83. The program/activities should be carried out continuously to increase knowledgements for teachers and students (Tan et al., 2020) such as counseling to teachers and students, such as training tools and software (Akçabozan-Kayabol et al., 2021) or develop online labwork for student for doing energy simulations (Hammad et al., 2020).

The data inferred that there are some points to recommend for future activities related to the topic, i.e.: (a) some program/activities should be carried out continuously to increase knowledge about energy storage technology and its relationship with lab work in schools for teachers and students, activities can be in the form of counseling to teachers and students; (b) collaborating with agencies that have experience in supercapacitor and battery technology, such as charcoal factories, (c) the participants could understand the ideas presented regarding knowledge of basic concepts and technologies energy conservations that can be applied in the manufacture of energy storage devices.

CONCLUSIONS

The activities of community services program are specifically carried out to the student and teacher at school. It went smoothly, interspersed with questions and answers. The assessment of the activities show that the activities designed can be used as labwork topics. It can be concluded that the series of activities in this community services program have received a positive response from the students and teachers present, which is shown from the satisfaction level of 3.40 - 3.83. Data from the table also suggests there some points to recommend future activities dealing with the topic.

The outputs obtained from this program included (1) the increasing the students' awareness to be involved in developing supercapacitors and batteries based on local materials; (2) Universitas Sriwijaya, especially the Faculty of Mathematics and Natural Sciences and the Fuelcell Research Center of Excellence, are increasingly recognized as institutions concerned with community problems, especially among the younger generation, such as students.

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