DESIGN, TEACHING ORGANIZATION OF SOLAR BATTERIES PROJECT IN HIGH SCHOOL

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Received on 22/7/2022, accepted for publication on 05/10/2022
DOI: https://doi.org/10.56824/vujs.2022ed02b

Abstract: Currently, the design and organization of project-based teaching is a practical matter, which has been widely applied to help learners acquire the necessary knowledge and skills to apply to specific and practical issues. In project-base teaching, theoretical knowledge is intergrated into practice to help learners practice how to apply theoretical knowledge to real life topics and situations. That will help students grasp the practical meaning of knowledge, and step by step understand how to apply in practice and solve real-life problems. One of the current urgent problems that need to be researched and solved is the problem of environmental pollution caused by climate change. Therefore, in this study, environmental issues are integrated into the curriculum, the research topic is the solar cell project taught in the form of a project-based at high schools. From the results of experimental pedagogical research, the effectiveness of teaching solar cell-theme projects at some high schools is evaluated.

Keywords: Project-based teaching; solar cell; environmental protection; physics.

1. Introduction

The research and innovation of teaching methods, transition from an academic education which is far from reality to an education that focuses on building learners' capabilities, is an urgent trend today and is being deployed strongly at all educational levels and all types of training.

The project-based teaching method is a form of teaching in which the learner is placed at the center, performing a specific task, combining theoretical knowledge and practice, resulting in specific, quantifiable products that can be evaluated visually and vividly. It helps students develop knowledge and related skills through self-exploring and self-proposing solutions to perform the assignments to solve the practical issue given by the teacher. The issues raised in project-based learning should be open, encouraging the creativity of learners. Teachers act as guides and consultants for groups of students during project teaching.

Currently, the application of project-based teaching has been widely deployed because of its effectiveness. In Vietnam, the project-based teaching method has been applied especially extensively at the university level. At the high school level, the application of the project-based teaching method has also been applied, however, the study of specific teaching contents and methods of implementing project-based teaching on specific topics has not been effective and needs further research on this issue. In order to contribute to improving the effectiveness of project-based teaching at the high school level,

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we have implemented a project-based teaching on the topic of solar cell when teaching Physics in order to develop knowledge, qualities and capacities for students. Through actual implementation, we will evaluate the effectiveness of implementation, and from the lessons learned, recommendations for others while implementing project-based teaching in high schools.

2. Learing goals of solar cell project

Solar cell, include many photovoltaic cells which are semiconductor elements containing on the surface of many light sensors are photodiodes, which convert the energy of light into electrical energy. Indicators such as amperage, voltage or resistance of the panel depend on the amount of light hitting the surface of the panel. These photovoltaic cells are combined into a block to become a solar cell (usually from 60 or 72 photovoltaic cells on a panel).

Solar cell is known as materials capable of converting sunlight into electricity. Electricity is generated from the light of the sun, just like hydroelectricity generates electricity from water, thermoelectricity generates electricity from coal... they have high efficiency and have an average lifespan of up to 30 years.

The theoretical basis of solar batteries is the photovoltaic effect, related to the knowledge of Physics grade 12. Thus, in the project-based curriculum in Physics for grade 12, it is possible to design a solar cell project with the following outcomes of knowledge, skills, and attitudes:

- In terms of knowledge: Students understand the history, structure, and operating principles of solar batteries. At the end of the project, students will understand how to manufacture, apply and use solar batteries effectively, economically, and contribute to environmental protection.

- In terms of skills: The following skills are formed, trained and improved: Problem identification and problem-solving skills; Information collection and processing skills; Experimental skills; Situational analysis skills; Presentation skills; Assessment skills, Teamwork skills.

- In terms of attitude: By collecting information, product assembly, presentation and evaluation of the project, students will have a positive attitude in learning and in life such as patience, honesty, solidarity and cooperation when working as a team.

3. Teaching activities of solar cell project

To carry out teaching activities of the solar cell project, students are organized into groups, which was assigned the task of implementing three activities, from the project identification step, explore to equip themselves with knowledge about solar batteries, formulate an implementation plan for the group, to the stage of project implementation, deploying solar panels assembly.

3.1. Project identification

In this step, the teacher poses provicative questions for the students to encourage exploration, discovery, and self-equipment of knowledge related to solar batteries. Teachers can instruct students to find out the answers for these following queries: “In recent years, Vietnam has continuously acknowledged in the North of Vietnam record heat levels and the record-breaking hot weather period. Due to the impact of climate change, it

is forecasted that the heat will be longer and longer, erratic and continuous, new records of temperature will be increasingly acknowledged. Let's find out the use of solar energy?".

From the given issue, students begin to explore, discuss and contribute ideas within each group. Teachers play the role of advisors, guides, directing groups to the content of the project is to use solar batteries. From there, the groups in the class will be guided by the teacher to formulate a tree diagram of subtopics around the "Solar cell" project.

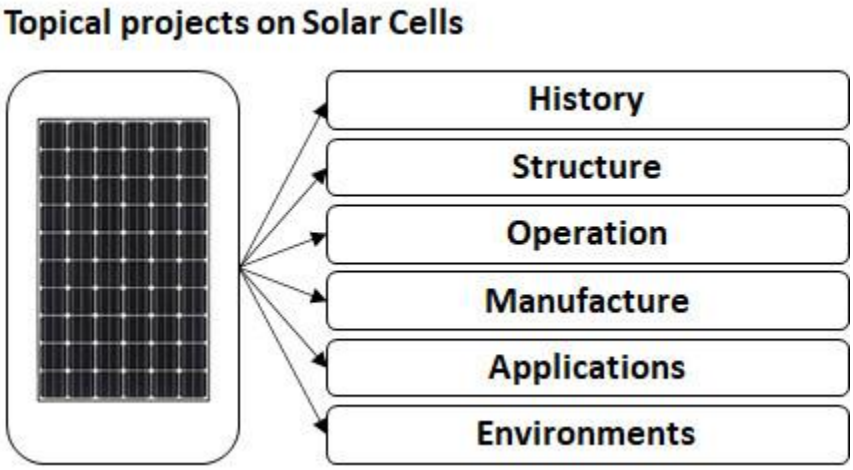

Figure 1: *Tree diagram of subtopics around the "Solar cell" project*

In order to implement all the contents of the project identification within the allowed time, the teacher divides students in the class into groups, each group will be in charge of a specific area as follows:

(1) Group 1: Historians - Learn the history of solar batteries.

(2) Group 2: Scientists - Learn the structure of a solar batteries.

(3) Group 3: Physicists - Learn the working principle of solar batteries.

(4) Group 4: Engineers - Learn how solar batteries are made.

(5) Group 5: Consumers and the environment - Learn how solar batteries are used and their environmental impact.

The time budget for exploring the subtopics is 20 minutes. After collecting and gathering information related to the subtopic, the groups will deploy the content of exchange, discussion and consensus within each group, the groups will give presentations on the collected knowledge content, and the teacher will guide, supplement and suggest more for the groups to complete the content.

3.2. Project implementation planning

The results of the study and discussion of the subtopics in activity 1 will help identify the key missions and formulate a detailed plan to implement the solar batteries project. Corresponding to the specific tasks of each group, as described in Section 3.1, each group will formulate a detailed plans to collect and handle information, conduct field survey, interviews, taking photos, filming, etc. to complete the final step of the project, which is the specific product. The duration for project implementation planning activity is 45 minutes.

3.3. Project execution

The project duration for each group is 1 week. Details are shown in Figure 2 - Historians, Figure 3 - Scientists, Figure 4 - Physicists, Figure 5 - Engineers and Figure 6 - Consumers and the Environment.

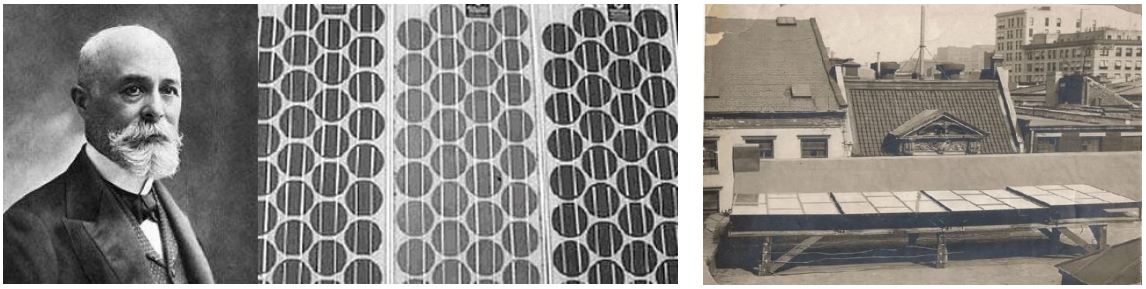

Figure 2: *Historians - Showcase and present informative pictures about the history of solar batteries*

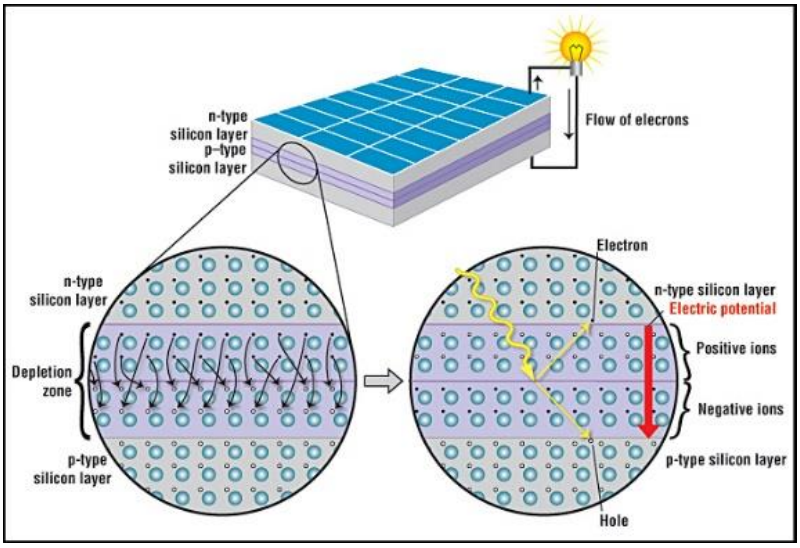

Figure 3: *Scientists - Displaying and presenting pictures of the structure of solar batteries*

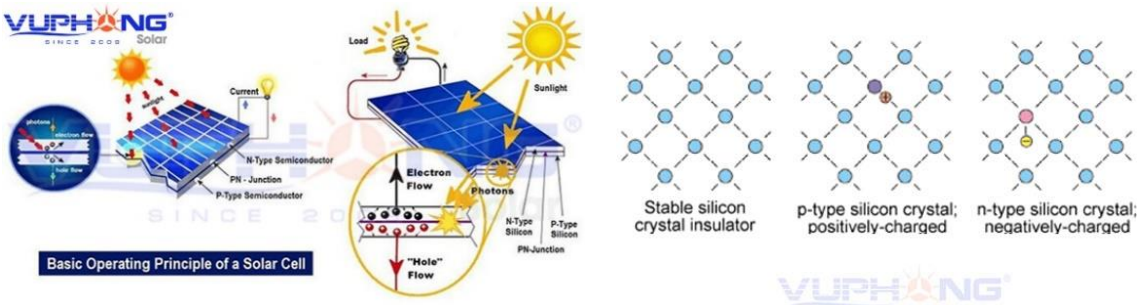

Figure 4: *Physicists - Display and presentation of pictures about the working principle of solar batteries*

Figure 5: *Engineers - Assembly, display and presentation of solar batteries products*

Figure 6: *Consumers and the environment - Demonstration and presentation of applications of solar batteries*

3.4. Project evaluation

In the estimated time of 45 minutes, the groups will present the results obtained after implementing the project through the displayed products. During each group's presentation, the remaining groups will ask questions under the guidance and advice of the teacher in order to reveal information and suggest more content related to the topic of each group. Thereby, the entire group will have a relatively complete knowledge of all the contents related to the solar batteries project.

The project evaluation is considered on almost all aspects of knowledge, skills, working attitude of all team members. Based on the implementation of the project and products of each group, the following specific criteria will be used:

- Project idea: Select project topic from real situation.
- The objectives of the project.
- The plan of the project.
- Project execution.
- Product reports and presentations: There is coordination between the reporter and other members in project presentations and project product announcements. Present in a timely manner, with sufficient content.
- Project evaluation: Demonstrate evaluation skills. Draw lessons for future projects.
- Evaluate the results of the project implementation.
- Self-collecting and handling information through document research, internet, actual investigation and survey, project experiment: Preparing materials and tools for model making, ensuring safety; Synthesize information.
- Team work (collaboration, sharing, responsibility, enthusiasm): Build and complete the product of the project. The members listen to discussions and actively participate in performing assigned tasks of the whole group.

In general, all groups actively participate in teamwork activities after understanding the importance of combining theory with practice (Figure 7). Solar panel products of the groups after finishing the project are shown in Figure 8.

Figure 7: *Active participation in group discussions and presentations*

Figure 8: *Solar panel project product*

4. The applicability of solar panel project teaching

In this study, the solar batteries project was conducted to organize teaching and pedagogical experiments at Tuong Duong 1 High School and Vinh University's High School for the Gifted. In order to have an accurate assessment of the applicability of the solar batteries project in Physics at the high school level, 06 Physics teachers from the natural group, Tuong Duong High School were consulted to evaluate the teaching content, deployment form, feasibility and effectiveness when teaching solar batteries projects. After attending the class, the teachers will give comments on the questionnaire according to the following levels: (1) Weak, (2) Average, (3) Fair, (4) Good. The obtained results are shown in Table 1.

Table 1: *Evaluate result on teaching content, deployment form, feasibility and effectiveness when teaching solar batteries projects*

Evaluation Criteria	**Rating level**			
	1	2	3	4
Regarding the teaching content				
Ensure accuracy, scientificity				6
Suitable for target audience				6
Suitable for teaching in the direction of developing students' capacities			2	4
Regarding the deployment form				
Scientificity				6
Consistency in presentation				6
Regarding the feasibility				
Suitable for students' learning level				6
Matching the teaching program			1	5
A creative experience activity for students			1	5
Regarding the effectiveness				
Students have the opportunity to develop their experimental, language, and communication skills			1	5

Evaluation Criteria	Rating level			
	1	2	3	4
Students use their acquired knowledge to solve practical problems				6
Students are more interested in learning				6

The results of the assessment, shown in Table 1, show that most of the teachers with the same Physics major have a good assessment of the teaching content, deployment form, feasibility and effectiveness when teaching solar batteries projects. There were 05 comments rated Fair in 04 criteria, however, none of them rated it as average or weak. Those results show that the application of the solar batteries project to teaching Physics at high schools is reasonable and consistent with the current educational goals.

The teaching results show that the application of the solar batteries project to teaching Physics at high schools has the following observable benefits:

- *Practicality:* The topic of solar batteries comes from a practical situation. The assignment of the project is suitable to the level and cognitive ability of learners, who are 12^{th} graders. This project contributes to correlate the study of Physics with real life and society.

- *Arousing students' interest:* In fact, when perform a project-based teaching at high school, students are allowed to participate in the selection of research tasks and contents in accordance with their individual abilities and interests. At the same time, during the project learning process, students do not have to spend too much time on theoretical lessons, which are so boring, but students can directly practice and experiment. This leads to excitement and effort to develop each individual's ability.

- *Action oriented:* When implementing the project, students can apply theory combined with practice, thereby helping to consolidate and expand theoretical knowledge and practice skills and practical experience of students.

- *Students' self-discipline and positivity:* Observing the practical teaching of the solar panel project shows that students participate very actively and voluntarily in all phases of the project. Teachers only play the role of advising, guiding, helping, and answering students' questions. Solar panel project is suitable for students' experience and ability. The difficulty level of the task posed in the project is appropriate.

- *Practice and promote teamwork skills, collaboration skills:* Students demonstrate relatively effective collaboration, reflected in the product results of the groups. Project-based teaching in general and teaching solar batteries project in Physics in particular helps students practice teamwork skills, collaboration skills among team members, and between students and teachers.

- *Creativity:* Each group has a different way of presenting their product. This is because the teams have different approaches to the problem from theory to practice, resulting in completely different products.

5. Conclusions

Project-based teaching is a form of student-centered teaching, where teachers act as consultants, guides, and prompts for students to come up with problem-solving solutions on their own. This form of teaching, in addition to developing knowledge and skills for

students, also encourages students to explore and and actualize the theoretical knowledge when participating in project-based learning and creating unique products, bearing the student's personal imprint.

In present study, a project-based teaching in Physics in high schools has been implemented, in which the project of designing and assembling solar batteries, referred to as the solar batteries project, was applied. The solar batteries project was conducted with teaching and pedagogical experiments at Tuong Duong 1 High School and Vinh University High School for the Gifted. Teaching results show that the application of the solar batteries project to teaching Physics at high school has noticeable outstanding advantages such as Practicality; Arousing students' interest; Action-oriented; Students' self-discipline and positivity; Training and promoting teamwork skills, collaboration skills; Creativity.

The evaluation results show that most of them give good reviews on the content, form, feasibility and effectiveness when teaching solar battery projects. The result proves that the application of the solar batteries project to teaching Physics at high schools is reasonable and consistent with the current educational goals.

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TÓM TẮT

THIẾT KẾ, TỔ CHỨC DẠY HỌC DỰ ÁN PIN MẶT TRỜI Ở TRƯỜNG TRUNG HỌC PHỔ THÔNG

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Ngày nhận bài 22/7/2022, ngày nhận đăng 05/10/2022

Hiện nay, việc thiết kế, tổ chức dạy học theo dự án là một vấn đề thực tiễn, đã và đang được áp dụng rộng rãi nhằm giúp người học nắm được kiến thức, kỹ năng cần thiết để áp dụng vào bài toán cụ thể, thực tiễn. Khi thiết kế, tổ chức dạy học bằng hình thức dự án, nội dung kiến thức lý thuyết được lồng ghép, tích hợp trong thực hành, rèn luyện cho người học cách vận dụng kiến thức đã được học vào các chủ đề, tình huống thực tiễn. Điều đó sẽ giúp học sinh nắm được ý nghĩa thực tiễn của kiến thức, đồng thời từng bước nắm được cách ứng dụng vào thực tiễn, giải quyết các bài toán thực tế. Hiện nay, một trong những vấn đề cấp bách, cần phải nghiên cứu giải quyết, đó là vấn đề môi trường ô nhiễm do biến đổi khí hậu. Trong nghiên cứu này, vấn đề về môi trường được lồng ghép vào chương trình dạy học, chủ đề nghiên cứu là dự án pin mặt trời được giảng dạy theo hình thức dự án ở trường THPT. Từ kết quả nghiên cứu, đánh giá được hiệu quả của việc dạy học dự án chủ đề pin mặt trời tại một số trường THPT.

Từ khoá: Dạy học dự án; pin mặt trời; bảo vệ môi trường; vật lý.