



Student Creativity through Project-based Learning Experiences

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This study aims to analyze students' creativity through project-based learning experiences in an electrochemistry topic. Subject of this study was 40 students from Chemistry Education Study Program who took basic chemistry course. Students experienced several activities, namely: forming groups of three, asking and refining questions, debating ideas, making predictions, designing plans and/or experiments, collecting and analyzing data, drawing conclusions, communicating their ideas and findings to others, asking new questions, and creating artifacts like a model, a videotape, or a media. Then, the lecturer monitored the students and the progress of the project, assessed the outcome and evaluated the experience resulting students-in-group' creativity profile. Research instruments are project assessment rubrics and observation sheets. Findings show that students' creativity in groups ranges from less to very good or from 48.15 to 92.59. Although there are still shortcomings with this study, we encourage other lecturers to implement this type of learning model in other courses or subjects in order to improve students' problem solving skills.

Keywords: Project-based Learning, Student Creativity, Electrochemistry

INTRODUCTION

Basic chemistry consists of several topics, namely: rate of reaction, oxidation-reduction reactions, electrochemistry, colloid, nuclear chemistry, organic chemistry, and biochemistry. Teachers tend to deliver electrochemistry concepts in the form of short explanation, drill, and reading assignments specifically in voltaic and electrolysis application subtopic. Although this course is supported by its practicum, students only conducted experiments related to calculation of voltaic cell potential (Lesmini and Desi, 2014). Mid-term exam scores also show phenomenon where students can solve calculation problem easily but they struggle in finding an answer regarding basic concepts, reaction and application of electrochemistry cell (Desi, 2018).

Moreover, students learned electrochemistry passively. They like listening information from teachers and taking note. They only utilized learning sources for example chemistry books or e-books partially. Teachers also applied a discussion method to explore student understanding and activity. However, the number of group members, usually more than 5 people, is being an issue for teachers to assess their involvement in assignments. Only one or two students worked together while others only sat without giving ideas in completing the task given. Therefore, we need a learning model that not only can improve student understanding in electrochemistry concepts but also develop their creativity.

Project-based learning is a model that involves students in complex tasks in cooperative learning groups. They work independently in understanding the topic and bring them up in real products. Such products are in the form of learning media designed independently by students and being representations of their understanding. In addition, the learning styles of each student are quite different, so this model provides an opportunity for students to explore content by using various meaningful media and conducting appropriate experiments collaboratively (Foundation, 2005). This might occur because project-based learning consists of six activities which include (1) preparation, (2) assignment, (3) planning activities,

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(4) investigation, discussion, and representation, (5) project completion, and (6) monitoring and assessing (Hutasuhut, 2010). Wrigley (1998) states that implementation of project-based learning could accommodate students to experience meaningful lesson. Learners will be given opportunities to discover information by themselves through books, do presentation, communicate their activities to peers, work in small-group, and propose suggestions or ideas. All activities describe how adults acquire meaningful learning. Therefore, it is crucial to implement project-based learning that not only provides activities but also can develop student creativity in designing products as a manifestation of their concept comprehension.

According to Nana and Sukmadinata (2005), creativity is an ability to create a new combination, based on available data or information. This information will give a possible answer for a particular problem which emphasize on quality, efficiency, and uniformity of solution. Therefore, creativity reflects someone's flexibility and originality of thinking and lead a person to gain an ability to elaborate an idea. Utami (1992) adds that there are several characteristic of creative attitude such as have high self-confidence, be open to new and extraordinary experiences, think and act wisely, have freedom of expressing ideas and imagination, interested in creative activities, and believe in their independent and own idea. Furthermore, Muliawan (2016) explains that there are seven creativity which are able to: recognize an object, speak, reasoning, behave, rearrange, imagine, and construct. Slameto (2015) suggests that students can be creative if they experience joyful learning, feel valued, involve actively in lesson, feel free to discuss problem, and face real-word issue. This study will show a profile of student creativity in designing a product through project-based learning. Also, the characteristics of product will be explored more in this study.

METHODS

Subject of this study was students of Chemistry Education Study Program enrolling Basic Chemistry course. This quantitative study measured the level of student creativity in designing product as a representation of their concept. This study followed project-based learning steps: start with the essential question, design a plan for the project, create a schedule, monitor the students and the progress of the project, assess the outcome, and evaluate the experience. This procedure can be found in Figure 2.

Rubrics of project assessment was utilized in this study. This assessment examined (1) ability of organization: choose subtopic, find information, and arrange timeline for data collection, and present product; (2) relevancy: compatibility with topic, considering knowledge, understanding, and skills aspects of learning; and (3) authenticity: their own idea while considering lecturer contribution in the form of instructions and support. It consisted of nine items and provided three scores. Final percentage of product is calculated utilizing formula Figure 1:

[Figure 1 about here.]

Then, the value obtained is confirmed by the criteria specified as in Table 1.

[Table 1 about here.]

[Figure 2 about here.]

RESULT AND DISCUSSION

Products created during project-based learning were spinning wheel, puzzle, board game, snake and ladders, video of voltaic cell, copper plating media, NaCl electrolysis media with carbon from pencil as electrodes, and electrolysis chart utilizing biomass like lemon, tomatoes, and star fruits. Score of spinning wheel media is 62.96 categorized as enough (Figure 3)

[Figure 3 about here.]

This media is compatible with learning objectives, giving information for readers about application of voltaic and electrolysis cell. However, this media may not help students to comprehend this concept because of the content. Apparatus of this media can be found easily at surroundings. Students can operate this media, but they confused related to the available questions about voltaic and electrolysis cell. The creators should provide instruction how to operate this media which can be followed by students. This media lacked of information and less accurate because there were unrelated terms or words except questions part in associated with electrochemistry. The product can attract student interest because it can create rap-turous learning.

Next media is puzzle (Figure 4) which is better than the former one in terms of appearance and usage because it is provided with instruction. Score of puzzle media is 77.78 categorized as enough. The limitation of this media is the quantity and quality of content regarding voltaic and electrolysis cell. It would be better if there is additional information packaged in puzzle form.

[Figure 4 about here.]

Board game (Figure 5) can be played easily supported by accessible apparatus. Score of board game media is 59.26 categorized as enough. However, the creators should consider availability of procedure, and completeness and accuracy of information. Therefore, students do not only focus on playing activity, but also can grasp electrochemistry concept.

[Figure 5 about here.]

Snakes and Ladders media (Figure 6) not only has a lot of information about the application of voltaic and electrolysis cell compared to three previous media, but also is supported with media instruction. This can motivate students to learn electrochemistry application because of its appearance and can broaden students' conceptual knowledge because of the availability of higher-order thinking problems. Score of snakes and ladders media is 85.19 categorized as good.

[Figure 6 about here.]

There was also a video of metal plating besides game media (Figure 7). This electroplating utilized a nail and a coin as electrodes. Score of this video is 77.78 categorized as good. This informative media can explain the process and reaction

involved during plating. However, lecturers should prepare laptop and LCD to display this process. There was another group choosing the same topic but their media was in the form of voltaic cell kit. Obstacles appearing in video can be handled, but a new issue emerged regarding the availability of CuSO_4 Electroplating Video in daily life. Therefore, students need to prepare alternative chemicals for electroplating which can be found in surroundings.

[Figure 7 about here.]

NaCl electrolysis kit (Figure 8) is another media developed by learners using carbon on pencil as electrodes. This media is better than previous media: electroplating kit. Chemicals and electrodes are easily obtained and harmless. Other students can observe any kind of reactions that might happen in a short period. However, this media needs manual procedure. Score of NaCl electrolysis kit is 77.78 categorized as good.

[Figure 8 about here.]

Finally, students constructed “charta” (Figure 9) to explain about electrolysis process utilizing different fruits: lemons, tomatoes, or starfruits. The average score of “charta” is 66.67 categorized as enough.

[Figure 9 about here.]

Physically, this media were less attractive compared to others because its nature is as one way media which may lead to passive learning. Based on Figure 9, students only focused on fruits as electrodes but they somewhat ignored the concepts of electrolysis application. If they brought a detail information in

associated with topics, modified some parts in this media, or added learning instructions or comprehensive questions, this “charta” will give a huge advantage in learning process.

In general, this project-based learning can construct students creativity in developing certain media which consist of concept and learning goals. Retnowita et al. (2018) states that the improvement of learner creativity was influenced by the implementation of project-based learning. Moreover, these media are representation of students comprehension regarding electrochemistry concepts. Usmeldi (2018) adds that interaction between project-based learning and creativity give an impact on students' competence.

CONCLUSION

Students' creativity improved through project-based learning implementation proved by learning media development: playing media, video, “charta”, or kit as a representation of their comprehended-voltaic and electrolysis cell concepts.

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Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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TABLE 1 / Score Conversion

Score	Category
86 – 100	Very Good
71 – <86	Good
56 – <71	Enough
41 – <56	Less
<41	Failed

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$$\textit{Final Score} = \frac{\textit{Item Score}}{\textit{Total Score}} \times 100$$

FIGURE 1 / final score formula

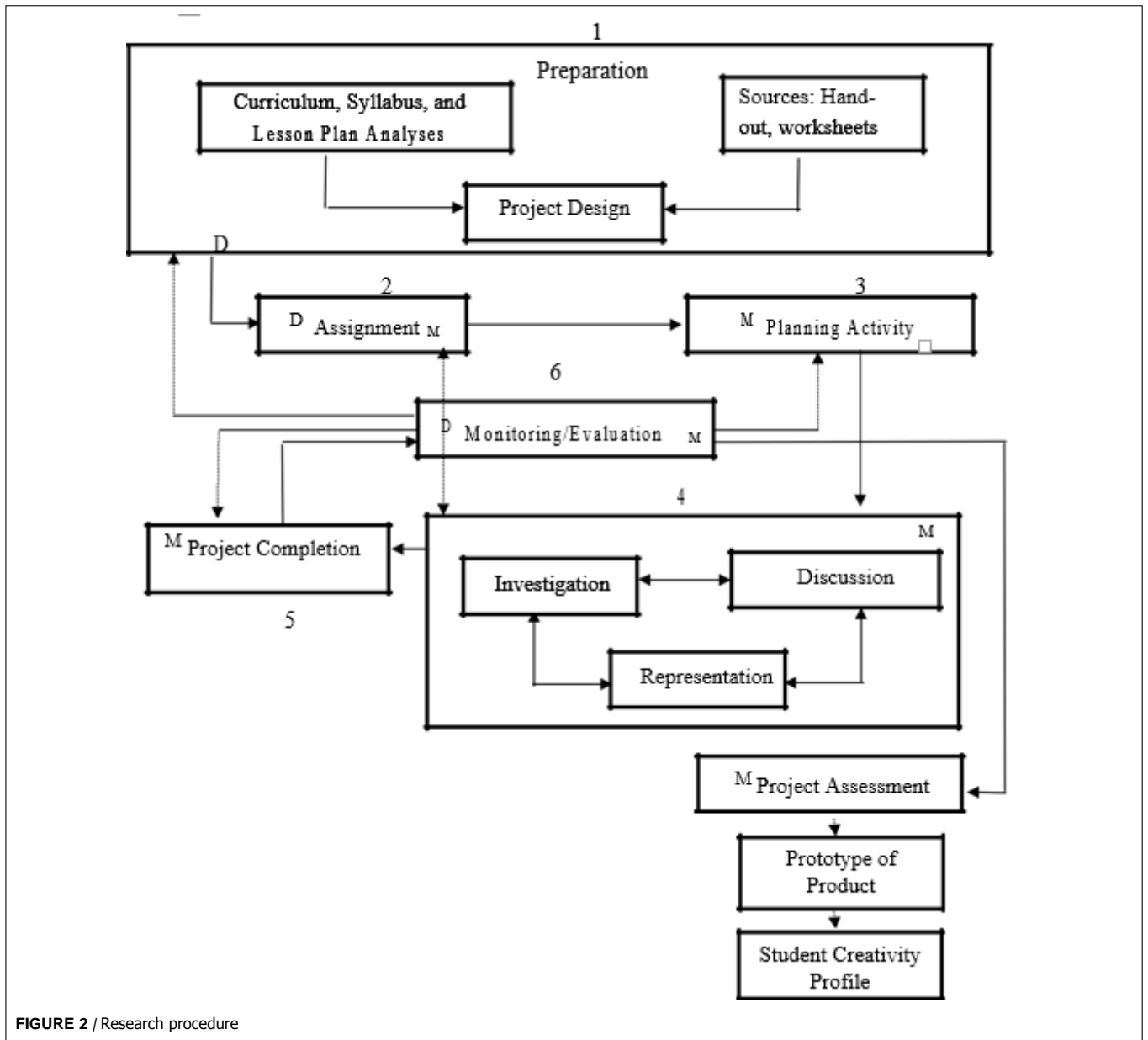


FIGURE 2 / Research procedure

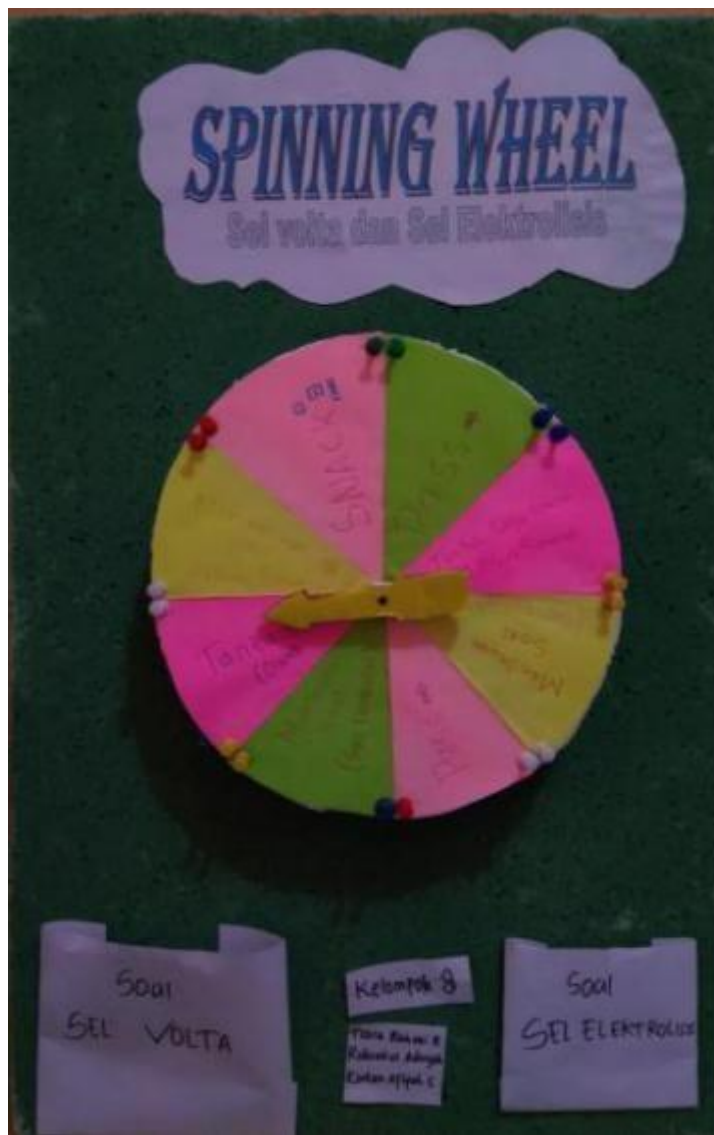


FIGURE 3 / Spinning wheel media



FIGURE 4 / Puzzle media



FIGURE 5 / Board game media



FIGURE 6 / Snake and ladders media



FIGURE 7 / Metal



FIGURE 8 / Electrolysis of NaCl kit

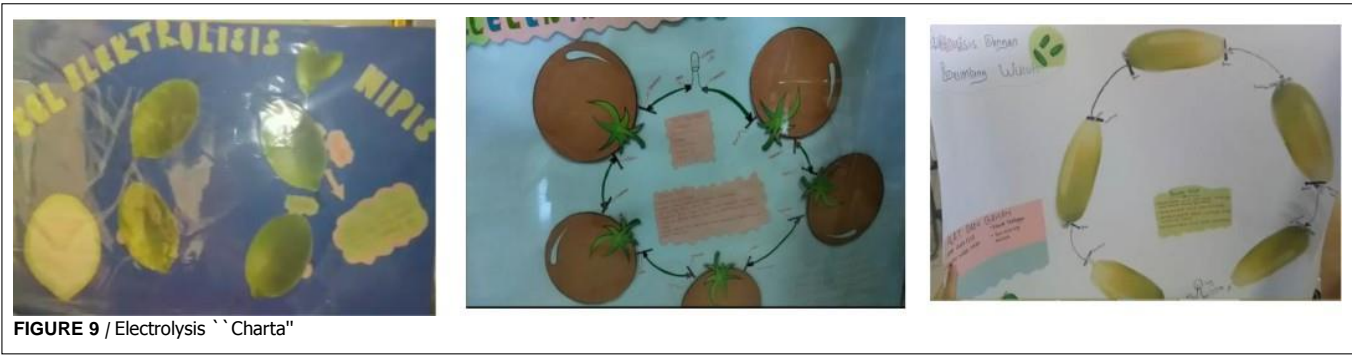


FIGURE 9 / Electrolysis "Charta"

