Project based learning to develop student’s creativities and characters in designing experiments

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Abstract. This study aims to analyze creativities and characters of students through project-based learning in designing experiments. Through the quasi-experimental method this research was conducted on 20 students who took experimental design courses. Through worksheets, product assessment sheets and attitude observation sheets the creativities and characters of students can be analyzed. The results showed that students creativities in making experimental designs in the form of flowcharts, to present, to create storyboards, to develop products from designing experiments had an average of 77.3, with good category. Meanwhile the characters developed were discipline with observable behavior that always came to the class punctually, spoke honestly, and remained confident even though the task that was doing was not satisfactory, the characters of responsibility with observable behavior was able to do the task without the help of others and diligently working on the task until it was finished.

1. Introduction

In creating meaningful learning an implementation of learning methods used is important to consider [1]. The application of science learning to everyday life requires educators to arouse students’ interest in developing science and technology through their creative ideas [2]. On the other hand, in the world of education science the ability of creativity from students is needed in learning [3]. This is because creativity originating from students is able to develop students' understanding, one of them is about projects and materials being studied [4].

The creativities and characters of students in learning are one of the demands of the implementation of the 2013 curriculum [5]. However, an emergence of an assumption that states that creativity and character cannot be learned and measured cause the development of creativity and character to receive less attention [6]. The conditions found in the field also show that the packaging of educational learning is still done through discussions, presentations and making papers. This condition causes the ability of students to be limited to theory and presentation [7].

In reality creativity to create new ideas is only owned by certain people. But in actually everyone also has the ability to think creatively. Whereas if someone's creativities are not developed then the individual can be said to only imitate and accept what has been done [8]. On the other hand, creativities
and characters by giving projects are able to push towards the original thinking of produced products. This is because the active creativities methodology is able to stimulate intrinsic motivation and trigger collaborative team involvement [9]. Thus, the achievement of higher creative thinking skills is needed in learning. The process must also involve monitoring the real involvement of all students [10].

The results of the study show that increasing creativity in students can be done by generating creative ideas that are in accordance with the applicable learning curriculum [11]. The creativity is basically the process of creating a product involving thought and characters, then through Project Base Learning, students’ creativities and characters can be improved by answering real problems that are solved through the creation of relevant products [12]. Project-based learning is conceptualized as a learning model that integrates concepts of knowledge, discipline, or field of study, and learning activities that take place collaboratively in heterogeneous groups [13]. Through project-based learning techniques, students can construct their own knowledge actively so as to change their attitude towards the complex and abstract concepts in a positive [14]. On the other hand, project activities in learning are needed to optimize competency skills and attitudes, especially laboratory work skills and cooperative attitudes [15]. The laboratory is a tool that can be used by students in improving skills through scientific experiments [16].

Character is the key to one's success based on the results of research in America, 90 percent of dismissal cases are caused by bad behavior such as irresponsible, dishonest, and good interpersonal relationships. Other studies indicate that 80 percent of a person's success is determined by emotional quotient [17].

Unlike the case with the studies that have been conducted, this study emphasizes more on project-based learning in developing student creativity and character in designing experiments.

2. Methods
The method in this study was quasi-experimental with a one-shot case study design [18] at one of the State Islamic Universities. Sixth semester students came from various high schools, so not all students are accustomed designing experiments. The stages of research began with problem identification, preparation, implementation and reporting. Data on students’ creativities and characters was obtained through observation activities during the learning process by observers and through analysis of the ability to create flowcharts, story boards, product development and product presentation capabilities. While the data for observing characters is seen from the developed character observation sheets.

3. Result and Discussion
The results of the study show that project-based learning develops students' creativity and character designing experiments is analyzed based on creativity indicators, namely: have high curiosity, have self-confidence, dare to express opinions, have high perseverance and have high imagination [19]. Based on these indicators, the creativity and character of students can be seen in table 1 below:

| No. | Creativity Indicators              | Presentation | Category    |
|-----|-----------------------------------|--------------|-------------|
| 1   | Have high curiosity               | 80.0 %       | Good        |
| 2   | Have confidence                   | 78.0 %       | Good        |
| 3   | Dare to express an opinion        | 75.0 %       | Sufficient  |

Based on table 1 above the indicator of having a curiosity observed from the number of students who ask in each learning process based on the results of the observations obtained a percentage of 80.0% is in the good category. Indicator of having self-confidence gained from the observation of the presentation process and self-assessment questionnaire with a percentage of 78.0% is in the good category. Indicator of dare to express opinions obtained from observations of the discussion and presentation process and self-assessment questionnaire with a percentage of 75.0% with sufficient categories.

Students creativities for indicators of having high perseverance and high imagination can be seen in table 2 below:
Table 2. Student Creativity on two Indicators

| No. | Creativity Indicators                  | Observed aspects | Presentation | Category |
|-----|----------------------------------------|------------------|--------------|----------|
| 1   | Having high perseverance               | Ability to make a flowchart | 76.0         | Good     |
|     |                                         | Ability to create a storyboard | 77.4         | Good     |
| 2   | Having a high imagination              | Ability to develop products | 78.0         | Good     |
|     |                                         | Ability of product presentation | 77.6         | Good     |

Average 77.3 Good

Based on the table above indicators of having high persistence observed from the ability of students to make flowcharts and storyboard the percentage obtained respectively by 76.0% and 77.4% in both categories. Indicators of having high imagination observed from the ability of students to develop products and product presentations obtained by the percentage of 78% and 77.6% respectively in the good category.

Indicators of having high imagination on some of the capabilities of developing products can be seen in table 3 below:

Table 3. Some examples of the titles of experimental designs

| No. | Practicum Title                        | Formulation of the problem                                                                 | Conclusion                                                                 |
|-----|----------------------------------------|-------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|
| 1   | Camphor dancing                        | Analyzing the effect of concentrations of HCl (acid) on CO₂ gas formation                  | The effect of the concentration of HCl (acid) on the formation of CO₂ gas is that the greater the concentration of acid, the more CO₂ gas formed will be |
| 2   | Instant fire                           | How is the effect of the anion in the reducing agent strong in producing a flame?         | Anions in compounds namely $\text{clo}_3^-$ > $\text{mno}_4^-$ > $\text{NO}_3^-$ This is sorted by the flame generated by the experiment |
| 3   | Black monument                         | How does the concentration of H₂SO₄ affect the formation of the black monument produced? | The higher the concentration of H₂SO₄ is used, the better it will be for the formation of a black monument |
| 4   | Determination of alkali metal content  | What is the optimum state of determination of alkali metal content with a flame test using the RGB color detector application? | Levels detected by the RGB Color Detector application on data I are 0.0313 g/mL, in data II is 0.0063 g/mL, and in data III is 0.00032 g/mL. |
| 5   | Playing with yeast                     | How does the amount of substrate affect fermentation?                                     | The amount of substrate involved in the fermentation process will produce more CO₂ gas and the required fermentation time is needed. |
| 6   | Determination of Iron Corrosion Rate   | How to determine the rate of reaction using the RGB camera application on the Smartphone? | Determination of Corrosion Rate can be determined through the RGB camera application where the Application will detect light absorption by the iron (II) n- (1,10-phenanthroline) complex by playing a spectrophotometric role and will then bring up the value of RGB ( Red, Green, Blue ) then the R value can be used to determine absorbance |
| 7   | Measurement of enthalpy of neutralization reaction | How is the effect of the type of calorimeter on the measurement of enthalpy of neutralization reactions? | Styrofoam cup calorimeters are more suitable for use as simple calorimeters because they have better insulator capabilities than paper. |
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| No. | Practicum Title | Formulation of the problem | Conclusion |
|-----|----------------|-----------------------------|------------|
| 8   | Colored trail  | How does the composition of the mixture of ethanol and water affect the trace length of the ink produced? | The composition of the solvent ratio used in this experiment does not necessarily affect the trace height of the ink produced, but it affects the position of the imprint of the ink produced because the ability of the soluble dyes will be different for each solvent |

Based on table 3 above the creativities of students in developing products are very diverse. This can be seen from several very interesting experimental design titles. There are 27 titles of students’ experimental designs, of which 27 titles were taken 8 examples of experimental design titles as found in the table above. Based on the experimental design titles above, students make many changes from various experimental variables so that the resulting design is different from the existing design, as stated by Wulandari that creativity is a person's ability to produce something new [20].

Indicators of creativities developed in project-based learning are very much in line with the characters of students who were observed during the learning process. Students’ characters that can be developed in project-based learning can be seen in table 4 below:

**Table 4.** Characters that can be developed in project-based learning

| No | Characters   | Observed behavior                                      | Percentage | Category |
|----|--------------|--------------------------------------------------------|------------|----------|
| 1  | Discipline   | Always arrive on time                                  | 96.3       | Very good|
|    |              | It is always on time when doing project assignments    | 88.9       | Very good|
| 2  | Honest       | Never peeked on other students’ works when doing tasks | 92.6       | Very good|
|    |              | Confidence when presenting the results of a project that they created | 78.0       | Good     |
| 3  | Responsible  | Doing project task corresponding to lecturers’ instructions | 92.6       | Very good|
|    |              | Sharing ideas or opinions when discussions in class    | 75.0       | Good     |
|    |              | Cleaning up the tools and place of experimentation     | 100        | Very good|
|    |              | Doing task until it is finished                        | 100        | Very good|

Based on the above table the characters that can be developed in the project-based learning process are carried out by observation and self-assessment questionnaire. Character of discipline can be observed with behavior always coming on time when working on project tasks given with the percentage obtained respectively by 96.3% and 88.9% with a very good category. Honest character with attitude do not peek the works of other students when doing the task obtained the percentage of 92.6% with the category of very good, self-confident behavior when presenting the results of the project that they made obtained the percentage of 78.0% in the good category. The character of responsibility by implementing project assignments according to the instructions of the lecturers, cleaning up the tools and place of experimentation and working on the task until it is finished with the percentages obtained were 92.6%, 100% and 100% respectively with very good categories and behavior promotes ideas or opinions during class discussions obtained a percentage of 75% in the good category.

4. Conclusion

Creativities of students with indicator of having curiosity obtained percentage of 80.0% with good categories. Indicator of having self-confidence obtained a percentage of 78.0% in the good category. Indicator of dare to express their opinions obtained a percentage of 75.0% with sufficient categories. Indicator of high persistence of in making draft in the form of a flowchart experiment had the average of 78.45 with good category, the ability to make a storyboard had the average of 75.8 with good category, the ability to present the products had the average of 77.7 with good category, the ability to develop products from designing experiments had the average of 78 with good category. Meanwhile,
character developed are discipline with behavior that always come punctually to attend learning, honest character that never peeked the work of friends when working on assignments, character of responsibility by implementing project assignments according to lecturers’ instructions, cleaning up tools and place of experimentation and working on the task until it is finished.

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