

Developing Creative Thinking Skills in Metal Purification Concept through Creative Problem Solving (CPS) Method

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Abstract: Students are not only required to have good cognitive abilities, but must also have creativity in facing global competition. In this study, student creativity has been developed by applying creative problem solving (CPS) learning to metal purification concept. The design of the method used is a one shoot case study with research subjects as many as 38 students of the second semester Chemistry Education study program. Data on students' creative thinking ability is measured through a creative thinking ability evaluation test consisting of indicators of fluency, flexibility, and originality. The value on the fluency indicator is 88 which is in the very good category. The value on the flexibility indicator is 72 which is in the good category. While the value in the originality indicator is 66 which is in the adequate category. Overall the level of creative thinking ability of students is at level three by achieving fluency and flexibility indicators and categorized as creative. CPS learning uses an approach centered on problem solving skills, which is followed by strengthening creativity so as to create a creative learning process. Thus, CPS learning on metal refining materials can develop students' creative thinking skills.

1 INTRODUCTION

In the 21st century, Indonesia as a developing country is in dire need of creative personnel who are able to improve the welfare of this nation (Noer, 2011). Student creativity is also required in the learning process, because college graduates must be able to apply logical thinking, critical, systematic, and innovative in the context of the development or implementation of science and technology that pay attention to and apply the values of humanities that are in accordance with their fields of expertise. In fact, in the learning process there are still many students who have low creative thinking abilities, thus it will be difficult to face global competition that not only requires an individual good cognitive abilities, but also has creativity (Sani, 2013). Based on this phenomenon, a learning model is needed that can develop students' creativity in order to achieve learning goals (Yudhanegara, 2015).

One of learning model that can develop creative thinking skills is the Creative Problem Solving (CPS) learning model (Lee, 2005). This model uses an approach that focuses on problem solving skills, which is followed by strengthening creativity

(Pepkin, 2009). Unlike general problem solving methods, this CPS learning model develops a series of ideas at the problem solving stage into new ideas to solve problems (Cardellini, 2006). Treffinger and Isaksen provide reinforcement that this CPS model can be used by individuals to formulate problems and analyze various kinds of effective problem solving to implement a solution with a series of new actions (Treffinger & Isaksen, 2005).

Characteristics of chemistry as a science are difficult to understand, require deep and creative thinking skills (Sari & Hidayat, 2017). One of chemical concept that is considered difficult to understand and is considered complicated is electrolytic cells (Subarkah *et al.*, 2016). Direct experiments are needed to better understand the concept of electrolytic cells (Subarkah *et al.*, 2016). Some concepts in electrolytic cell are abstract but have concrete examples in everyday life (Subarkah *et al.*, 2016), such as changes in electrical energy into chemical energy in the process of metal plating (electroplating) and metal purification (electrometallurgy) (Jespersen *et al.*, 2012). Metal purification material is not sufficiently understood with the level of basic thinking, because the learning

objectives expected from learning this material are students can evaluate the symptoms or processes that occur in it so that the development of creative thinking skills is needed (Humaeroh, 2016). Metal refining material is a relevant material for developing creative thinking skills, because the key to creative thinking is thinking to design, solve problems, make changes and improve and get new ideas (Bono, 2007). Therefore, in this research, the application of creative problem solving learning (CPS) to develop creative thinking ability in metal purification concept is studied.

2 RESEARCH METHODOLOGY

This research applies a class research method with one shoot case study research design, i.e. research carried out without the presence of a comparison group, to determine the effect of the treatment given without regard to other factors (Sukmadinata, 2007). At the beginning of the study, students watched videos about gold metal purification and were asked to explain the contents of the video. Then the students were given worksheets about copper metal purification and students were asked to follow the instructions and answer questions in the worksheet in groups. Furthermore, students are instructed to make an efficient copper metal purification product that will be used for experiments at the next meeting. After successfully making copper metal purification equipment, students conduct experiments using the tools that have been made and report the results of the experiment. Finally, students are given evaluation questions to determine students' creative thinking skills after the implementation of CPS learning. Determining the level of creative thinking ability, namely at level 4 students can achieve three indicators of fluency, flexibility and originality which are categorized as very creative, at level 3 students can only achieve two indicators of fluency and originality or flexibility and originality which are categorized as creative, at level 2 students only achieve one indicator of flexibility or originality which is categorized as quite creative/adequate, while at level 1 students only achieve fluency indicators which are categorized as low creativity, and at level 0 students cannot reach these three indicators and are categorized as very low creativity.

3 RESULTS AND DISCUSSION

Students' creative thinking skills were measured using evaluation tests that include fluency, flexibility, and originality indicators. The indicator of fluency is the ability to produce many ideas. In measuring fluency, students are asked to think of many different solutions for a problem. Flexibility indicator is the ability to produce uniform ideas, be able to change ways or approaches and have different directions of thinking. Flexibility is measured in terms of individual abilities in trying approaches or ways to solve a problem. While the originality indicator is the authenticity of the ideas produced in responding to the idea correctly. The originality indicator is measured by evaluating unusual solutions or new solutions given by students (Kaplan *et al.*, 2005). The results of the analysis of each indicator of creative thinking ability, i.e. fluency, flexibility and originality are presented in Table 1.

Based on Table 1, the average value of the creative thinking ability test on the fluency indicator obtained is 88 points with very good categories. As for the learning achievement group, the higher group obtained an average score of 90 with very good interpretation. The group was getting an average score of 91 with very good interpretation, and the lower group obtained an average score of 84 with very good interpretation. In this indicator of creative thinking abilities all students can easily master the fluency indicators. This is seen from the acquisition data which states that all learning achievement groups obtain an average score above 80 with very good interpretation. The success of this indicator when learning using the CPS model precisely at the clarification of the problem stage, students have been able to link problems with the concepts learned so that they can determine the main problem appropriately. The connection between the problem and the concept will help students to learn so that they can solve problems (Suma & Suastra, 2013). As a result, students are accustomed to seeing problems from various points of view so that students easily clarify the problem (Trianto, 2009) i.e. curiosity, independence, problem solving and linking problems (Sari & Hidayat, 2017). In addition, the criteria for the questions are having more than one answer make students able to solve them easily (Siswono, 2011).

The overall analysis results on the flexibility indicators obtained by students are interpreted as good. This can be seen in the average value obtained on the flexibility indicator of 77. As for the learning

Table 1. Analysis of Creative Thinking Ability Test Results on Each Indicator based on Learning Achievement Groups

Student Achievement Group	Aspects of Creative Thinking Ability			Score	Interpretation
	<i>Fluency</i>	<i>Flexibility</i>	<i>Originality</i>		
Higher group	90	81	72	81	Very creative
Medium group	91	72	69	77	Creative
Lower group	84	62	56	67	Creative
Average	88	72	66	75	Creative
Category	Very good	Good	Adequate		

achievement group, the higher group obtained an average score of 81 with very good interpretation, the medium group was getting an average score of 72 with very good interpretation, and the lower group achieved an average score of 62 with good interpretation. Based on observations that have been made during CPS learning, precisely at the stage of brainstorming, students actively discuss their ideas to create hypotheses. With discussions, groups of students can solve problems that they may not solve themselves (Cardellini, 2006). Discussion can encourage students to think and improve the ability of students who have average or low achievements to participate in the learning process (Djamarah & Zain, 2006). As a result, students are used to answering questions with different answers than usual, so that the approach to answers to students always has the different answers.

In the third indicator that is originality, the overall results are interpreted as good. This is seen in the average value obtained in the originality indicator that is equal to 66. As for the learning achievement group, the high group gets an average value of 72 with good interpretation, the medium group is getting an average score of 69 with good interpretation, and the lower group gain an average score of 56 with a fairly good interpretation. Originality indicators are developed during CPS learning, precisely at the implementation stage. At this stage students are instructed to make efficient copper metal purification products. The aim of making copper metal purification equipment is to develop the originality of thinking skills that students have. In this case Nirmala (2010) explained that the ability to think creatively can be developed by making learning products. With the creation of learning products, students' thinking power can develop (Fatmawati, 2011). In addition, assigning students to make learning products can foster learning motivation which is the key to success in the learning process (Lam *et al.*, 2009). In the higher achievement group, the group get the highest score

because the the students can express ideas that are rarely expressed by most students, while in the lower achievement group get the lowest score because they only able to provide answers that are fixated on the textbook. Originality is the main characteristic in assessing a product of creative thinking that must be different from before (Siswono, 2011). Therefore, the originality indicator is considered very important in knowing students' creative thinking skills. But in the test of creative thinking skills carried out by researchers, the achievement of these indicators of creative thinking is in the lowest position when compared with other aspects of creative thinking such as flexibility and fluency. This is because the originality indicator is at the highest level of difficulty between the two indicators of other creative thinking abilities so that students still experience difficulties in achieving these aspects. Student difficulties due to learning resources are not allowed to be used during this test.

Based on the description of the three indicators of creative thinking, the highest average score is found in the fluency indicator with very good interpretation. Meanwhile, the indicator of creative thinking with the lowest achievement is on the indicator of originality with sufficient interpretation. Overall the level of creative thinking ability of students is at level 3 with the achievement of fluency and flexibility indicators and categorized as creative. The number of students at each level of creative thinking ability based on group learning achievement can be seen in Figure 1.

In Figure 1, the higher achievement groups of 5 people were in level 4 with very creative categories and 3 people included in level 3 with creative categories. While in the medium achievement group as many as 9 people were at level 4 with a very creative category and 18 people included in level 3 with the creative category. In lower achievement group, 3 people are included in level 3 with creative categories and 1 person is at level 2 with quite

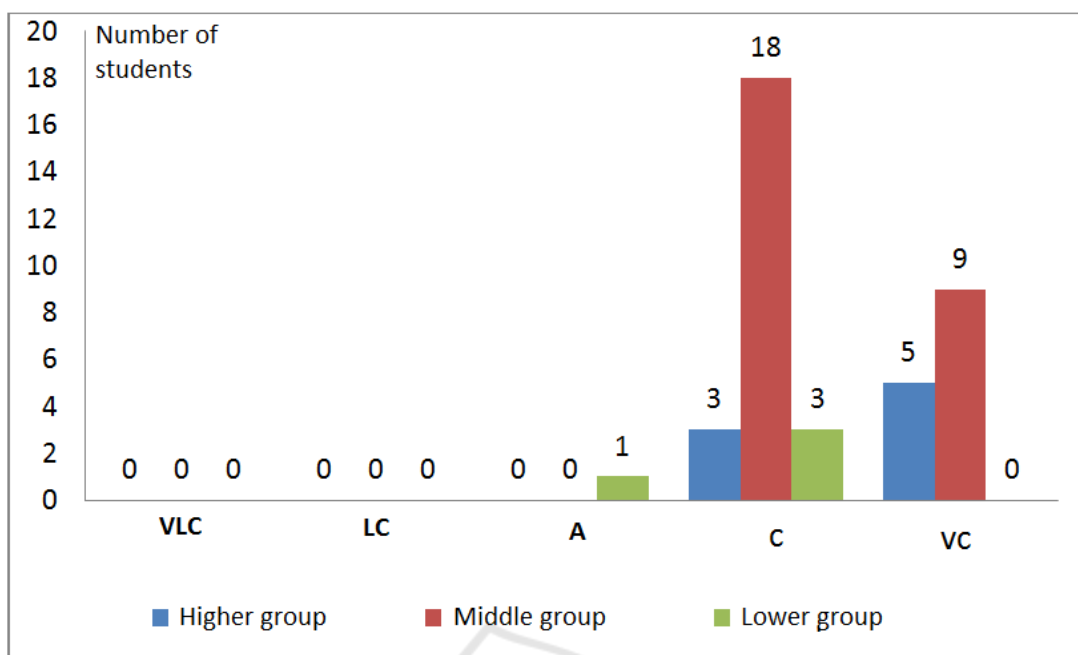


Figure 1 Number of Students at Each Level of Creative Thinking Ability based on Achievement Groups (VC: Very Creative, C : Creative, A: Adequate, LC : Low Creativity, VLC : Very Low Creativity).

creative categories, but no students are included in level 4. The highest number of students is included in level 3, with total 24 students from higher achievement group, medium and lower group.

The sequence of levels of creative thinking ability based on learning achievement groups are as follows: in the first place is the higher group at level 4 categorized as very creative with the achievement of indicators of fluency, flexibility and originality. Meanwhile, the third order is occupied by a lower group that is at level 3 categorized as creative with the achievement of fluency and flexibility indicators. Overall the average value of each group of learning achievement is at level 3 with the achievement of fluency and flexibility indicators which are categorized as creative. Thus CPS learning plays a role in developing students' creative thinking skills.

4 CONCLUSIONS

The creative thinking skills of students developed through CPS learning on metal purification material as a whole are at level 3 and categorized as creative with fluency indicators reach very good category, flexibility indicators achieving good category, while the originality indicator only reaches adequate category.

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