DEVELOPING CREATIVE THINKING SKILLS AND CREATIVE ATTITUDE THROUGH PROBLEM BASED GREEN VISION CHEMISTRY ENVIRONMENT LEARNING

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ABSTRACT

The purpose of this research is to build creative thinking skills and creative attitude of students through a model of problem-based lectures environmental Chemistry (*PBL*) Green Chemistry visionary. Mixed methods research design experimental models embedded with pretest-posttest control group were used in this study, and the differences between assumed initial end-tests as the effects of the treatment. Creative thinking skills measured by the essay tests, non test while the creative attitude is measured from the completed questionnaires consisting of positive and negative statements of markers creative attitude. Data measurement N-gain of creative thinking skills for the control and experimental group were 0.40 and 0.71, while the creative attitude were 0.08 and 0.34. Improved tests of creative thinking skills or creative attitudes were analyzed by t-test. Implementation of research findings indicate environmental chemistry lecture- problems based Green Chemistry vision can improve thinking skills and of creative student.

Keywords: Green Chemistry, creative thinking skills, Environmental Chemistry, creative attitude, Problem-based learning (*PBL*)

INTRODUCTION

Environmental Chemistry lectures that have been held in universities both LPTK or non LPTK, has been trying to get students more responsive to environmental issues. To achieve these objectives the college has conducted several lectures with various strategies, but students are still less able to apply their chemical knowledge in solving real problems, handling of data and information, let alone give the idea of problem solving. Moreover, attitudes and behaviors when asked to study the field or outside the lecture, can not be relied upon as an example or role model. In addition to the multiple choice questions or a description given in the midterm or final exams was also less representative of the overall sub-materials studied, as well as the lack of training of high-level thinking (Nuswowati, 2009 and 2011).

Efforts to improve the creativity has been done by way of developing the learning in the classroom is oriented creative thinking skills enhancement (Slavin, 2009). De Bono (2007), found that the creative problem-solving exercises can improve creative thinking skills. Koray & Koksal (2009) study on the implementation of laboratory-based creative thinking and critical thinking significantly influence the improvement of creative thinking skills. Price et al. (2009) on the application of technology in learning can provide implications for the development of new knowledge, creative thinking and good communication skills. Based on factor analysis Guilford (1977) found five properties that characterize the creative thinking abilities, namely: smoothness (fluency), flexibility (flexibility), authenticity (originality), decomposition (elaboration), and reformulation (redefinition). Salsedo (2006) explains that the measurement of creativity as a product

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meant to focus on the results of creative activity, as the process is meant to focus on how individuals in expressing their creativity, and as a means to focus on the attitude of the personality, interests, motivation and other personality factors related to creative activities. Among a variety of innovative and creative approaches that exist, Problem Based Learning (PBL) is one approach that could potentially be used in lectures Environmental Chemistry. Alejandro et al. (2010) state that PBL system is widely recognised as a strategy for effective learning. Learning through practice to solve actual problems potentially increase the likelihood of students see the reality what is done, so that students feel kontens and context (Johnson, 2002; Liliasari, 2009). The advantages of PBL, is primarily in helping students develop thinking skills, problem solving skills, intellectual skills: study the role of adults with experience through a variety of simulated situations; and become independent learners and autonomous (Arends, 2008). Lectures with problem-solving strategies can also build the process of thinking, student engagement, communication skills and share information (Akinoglu & Tandogan, 2007). Issues relating to the current physical environment include environmental pollution with all its impacts (Manahan, 1994; Rukaesih, 2004).

In the student closer to the vision of the world on the environment, the problems in the vision of Green Chemistry into a very interesting thing to use as context problems. As is known, Anastas & Warner (1998), who was acting as Implementing Environmental Protection (Environmental Protection Agency) in the United States developed 12 principles of Green Chemistry (Sustainable Chemistry) which can be used to explain the meaning of the definition in practice. Therefore, through lectures environmental chemistry, chemistry teacher candidates are taught to help build creativity, togetherness and innovative ideas / ideas and willing to take action to solve environmental problems.

A PBL classroom is organized around collaborative problem-solving activities thatprovide a context for learning and discovery. Collaboration both within and betweengroups forces students to reflect on their peers' and their own problem solving. The reason why teachers put students in cooperative learning groups is so all students can achieve higher academic success individually than were they to study alone (Ram, 1999).

Revisiting the purpose of environmental chemistry lecture, the advantages of the PBM, and the importance of carrying the vision of Green Chemistry in solving the problem, then the course should be designed primarily to help students develop the skills to think and be creative in solving environmental problems. Based on the description that has been stated, the problems that arise and be resolved are: 1) How creative thinking skills of students in solving environmental problems after the implementation of the model-based lectures Environmental Chemistry Green Chemistry vision problems? 2) What is the attitude of students creative in solving environmental problems after the implementation of the model-based lectures Environmental Chemistry Green Chemistry vision problems? 3) How is the response and suggestions on the implementation of a model student lectures Environmental Chemistry Green Chemistry-based vision problem.

METHOD

This research includes mixed research methods using embedded Experimental models (Creswell & Clark, 2007). Subjects in the study were students at the State University of Semarang, Central Java Education Studies courses contracting Chemistry Environmental Chemistry. The instruments used are: (1) tests of creative thinking skills, (2) test marker creative attitude, and (3) questionnaire to determine the response of students to model applied. Data processing is performed by calculating a score gain normalization and correlation, while the questionnaire data be converted into a qualitative scale quantitative scale.

Increased creativity (creative thinking skills and creative attitude) that occur before and after learning the normalized gain calculated by the formula (N-gain) (Hake, 1999).

$$g = \frac{S_{post} - S_{pre}}{S_{maks} - S_{pre}}$$

With the score is the final test, is the initial test score and is the maximum score. Hake in accordance with the opinion that the acquisition criteria scores g with the high category, g> 0.7 is a high category, $0.3 \leq g \leq 0.7$ is the medium category and $g < 0.3$ lower category. Increased creative thinking skills test results or creative attitude analyzed by t-test.

RESULT AND DISCUSSION

1. Creative Thinking Skills

Acquisition of an average score pretest, posttest and normalized gain in the experimental class and control class as a whole can be seen in Figure 1. Prior to the lecture (pretest), creative thinking skills of students in the class is the same compared to the 39. After the lecture, average skills creative thinking is the experimental class 83 and class control is 64.

Furthermore, to see the significance of the increase in creative thinking skills, statistical tests performed using SPSS with the results as shown in Table 1. Although overall, the increase creative thinking skills experimental class is higher, but there are some indicators show an increase less in line with expectations.

Comparison of creative thinking skills upgrading for each indicator in detail in the experimental class and control class, shown in Figure 2.

The mean increase in creative thinking skills in the classroom is the lowest control indicator 1 (N-gain 0.38) and the highest is the indicator 2 (N-gain of 0.42). N-gain indicators 1, 2, 3, 4, or 5 on the control classes including medium category. The average N-gain at the lowest experimental class is an indicator 2 (N-gain of 0.60), and the highest is the indicator 5 (N-gain 0.82). The experimental class, N-gain indicators 1 and 2 creative thinking skills included in the medium category, while indicators 3, 4 and 5 were high. Although students in the control class has to have the skills to think creatively on each indicator and the average N-gain the skills of creative thinking in the category of being, but the increase is much different from the experimental class. This finding is in accordance with the reports of Beetlestone (2011), Tosun & Taskesenligil (2011), and Rosita et al. (2014) which concluded that the creative thinking skills exist in all people, schools and teachers need to adopt and apply an approach that supports these skills if you want to educate students to become creative children. This shows that the model of lectures that have been made less support creative thinking skills of students compared with applying the model developed by the PBL.

Results of testing the significance of the increase in creative thinking skills of students in the experimental class and control on every indicator. Normality test results show the value of F and the significance greater than 0.05 so that the data are normally distributed. The second class homogeneity testing shows indicators 1: detect, recognize the existence of the problem, 2: predicting pollutant sources and their impact if not addressed, 3: consider solving previous investigators, 4: sparked the idea and 5: designing creative action steps is homogeneous because all grades F greater than 0.05.

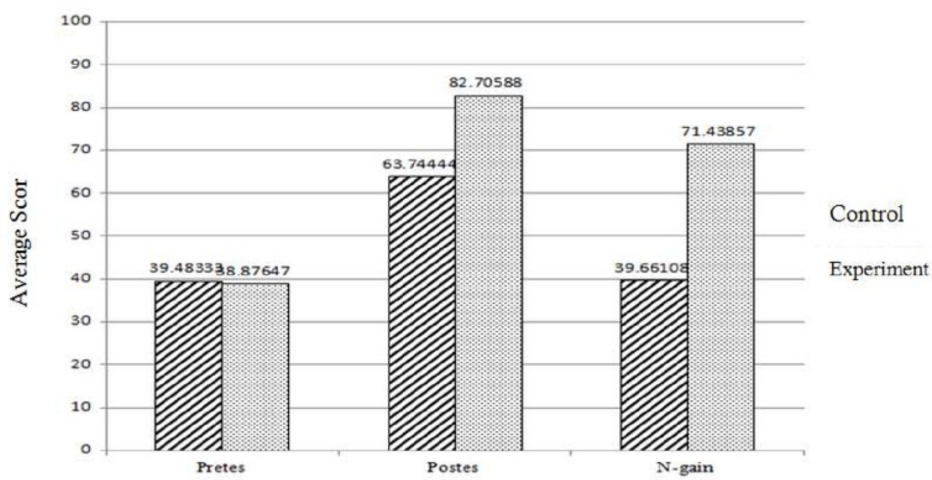

Figure 1. Mean pretest, posttest and n-gain control class creative thinking skills and overall experiment

Table 1. Results of Testing Against Statistics Creative Thinking Skills Improvement

Class	N	Normalitas Test (Kolmogorov-Smirnov)	Homogenitas Test (Levene's Test)	t-Test *(2-tailed)*	Expla-nation
Experiment	34	Sig.= 0,778	F= 0,017	T_{hit}= 15,920	Significan
Control	36	Sig.= 0,650	Sig.= 0,897	Sig.=0,00	

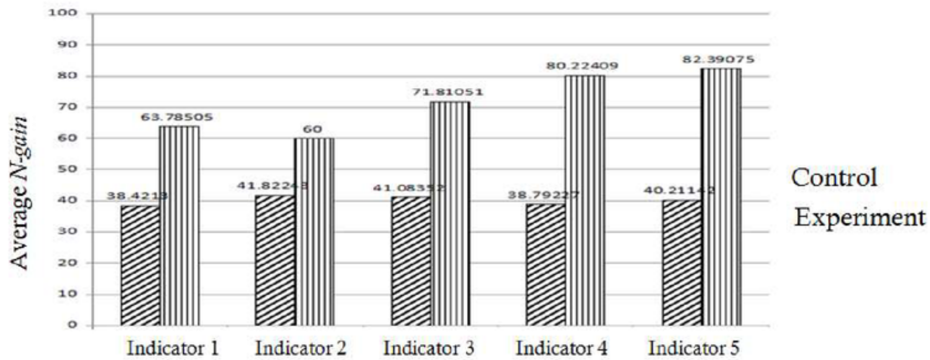

Figure 2. Comparison of creative thinking skills enhancement for each indicator on implementation

Specification:
Indicator 1: Able to detect, recognize, and understand and respond to their environmental problems.
Indicator 2: Being able to predict the source of environmental pollution and its impact, if not addressed
Indicator 3: Ability to consider the solution or approach to solving existing environmental pollution.
Indicator 4: Able to spark ideas in ways that are original and Green Chemistry in solving the problem of environmental pollution
Indicator 5: Ability to specify in detail, designing the actions taken steps to resolve the problem of environmental pollution, in which there are in the form of tables, graphs, drawings, models and or words.

Statistical tests towards the improvement of each indicator creative thinking skills, all indicators are higher and significant increases in the experimental class compared with the control class. PBL stages are integrated into the creative thinking skills, encouraging students can spark new ideas. Finding results are consistent with the creative learning model (Rusman, 2009), which emphasizes the aspects to train creative thinking skills of students in participating in the classroom.

Based on the test results prerequisite then using parametric statistical tests (t-test) all indicators show the Sig. <0.05 and t_{count}> t (68; 0.05) so that Ho refused. This demonstrates the ability of creative thinking of students in the experimental class better than students in the control class in all indicators of creative thinking skills.

The calculation result of correlation score of each indicator creative thinking skills to creative thinking skills total score (Pearson Correlation) showed that the relationship between the indicator 1 for total creative thinking skills of students at 0.79 in the high category. Because the significance value less than 0.05 it can be concluded significant correlation results. That is one indicator of the contribution to the total score high students creative thinking skills.

The relationship between the indicators 2 for total creative thinking skills of students at 0.85 in the high category. Because the significance value less than 0.05 it can be concluded the results were significant correlations. This means that the contribution of the indicators 2 to the total score high students creative thinking skills. The relationship between the indicators 3 with total creative thinking skills of students at 0.76 in the high category. Because the significance value less than 0.05 it can be concluded the results were significant correlations. This means that the contribution of indicator 3 of the total score high students creative thinking skills. The relationship between the indicators 4 with total creative thinking skills of students of 0.66 is included in the medium category. Because the significance value less than 0.05 it can be concluded significant correlation results. This means that the contribution to the total score indicator 4 creative thinking skills of students being. The relationship between the indicator 5 with total creative thinking skills of students of 0.54 is included in the medium category. Because the significance value less than 0.05, it can be concluded significant correlation results. This means that the contribution to the total score indicator 5 creative thinking skills of students being.

From the description of the correlation score of each indicator against a total score of creative thinking skills, all the indicators have a significant correlation. Indicator 1 (detecting, recognizing the existence of the problem), 2 (predict pollutant sources and their impact if not addressed), and 3 (consider solving problems previous investigators) highly correlated, whereas 4 (sparked the idea) and 5 (designing creative action steps) is correlated being.

These findings indicate that the results of the election, suppression and modification indicator creative thinking skills have been successfully to train creative thinking skills students step by step in the lecture. Indicator 1, 2 and 3 correlated in achieving a total score of creative thinking skills, while indicators 4 and 5 were correlated in achieving a total score of creative thinking skills. From these findings, it is necessary to emphasis on student to train process in initiating ideas in ways that are original and Green Chemistry in solving the problem of environmental pollution want to specify in detail, designing the actions taken steps to resolve the problem of environmental pollution, in which there are tables, graphs, drawings, models and or words.

It is interesting to study is the existence of some differences in creative thinking skills of each indicator test results with implementation. The interesting finding is a comparison of the increase in creative thinking skills for classroom testing and implementation class, ie on indicator 1 (the ability to detect, recognize, and understand and respond to the environmental problems). N-gain test class (0.80) better than the experimental class (0.64). For more details can be seen in Figure 3. Decrease creative thinking skills on one indicator is due to the implementation process less given examples to detect, recognize, and understand and respond to problems. This is because in trials such skills have improved either.

It should be emphasized to achieve the objectives of this research, the steps that have been established PBL consisting of five indicators of creative thinking skills, should always be carried out in accordance with the stages that have been set as well. As the results of preliminary studies (Nuswowati, 2011), five of the eight professors Environmental Chemistry said that the model of the course most suited Environmental Chemistry is PBL, but did not want to do because they have to work hard during the preparation or in the implementation. Indeed, in the implementation of each step in the PBL, the lecturer should function as: a facilitator, facilitator, trainer, consultant, motivator and evaluator. Two other professors who answered Contextual Teaching Learning (CTL) is most suitable in the lecture Environmental Chemistry. As for the other lecturers who replied field study.

2. Creative Attitude

The results showed that in general the students have increased in the creative attitude that assessment through questionnaires marker creative attitude to the category of "moderate". The average achievement of creative attitude in the experimental class and control, to pretest is the same namely 69, while the posttest was 78 and 71. N-gain for the experimental class reached 0.34, including the medium category, while N-gain control class 0.8, including low category,

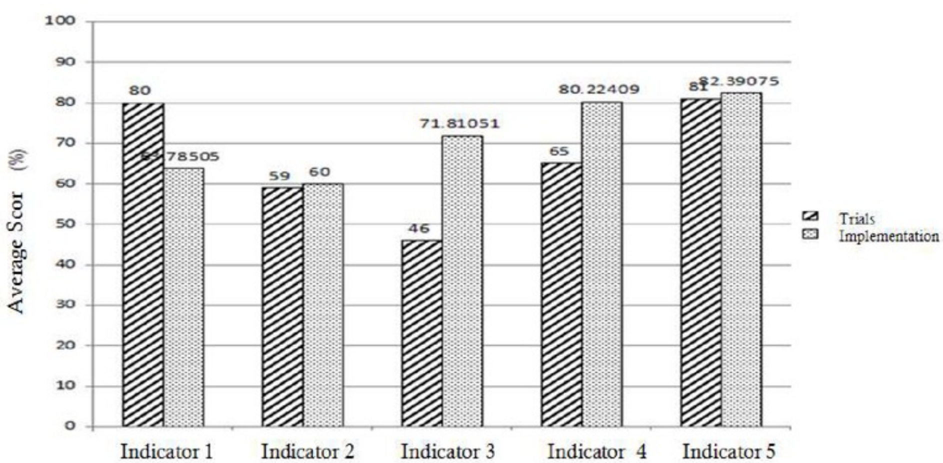

Figure 3. Comparison of increase in each indicator between the creative thinking skills testing and implementation

can be seen in Figure 4.

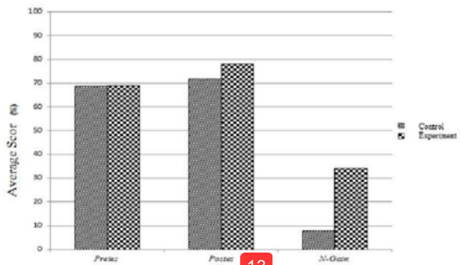

Figure 4. Achievement of the average pretest, posttest and n-gain creative attitude in the control and experimental classes

To find out more creative attitude whether the achievement of students in the experimental class better than the control class, which is contained in Figure 5 is significant, then the statistical testing with the Sig. Kolmogorov-Smirnov test is greater than 0.05, both normally distributed data.

Test homogeneity (Levene's test) showed both the data are homogeneous (Sig.> 0.05) so that statistical testing using t-test (two-tailed) are parametric. Results of statistical calculations showed Sig. <0.05 and thit = 13.28, concludes increase creative thinking skills and the different experimental class improved significantly compared with the control class. Although the lecture-based Environmental Chemistry Green Chemistry vision problems increase the achievement of value creative thinking skills and creative attitude, but the two are not related. Means the achievement of students who score higher thinking skills are not necessarily creative attitude is also good. The answer given is a marker of creative attitude to be expected, but not necessarily the students act like it. This is according to the results of research Rosita et al. (2014) which states that the creative mind higher correlation with the creative writing ability compared with a creative attitude.

The possibility of this is due to the creative attitude only reveal a feeling of something and behaviors that contains an opinion about something. Creative thinking skills are trained in the lecture in this study can indeed improve creative attitude. Achievement of creative attitude is not entirely a real reflection of the creative act as expectations, likely the students know how she must be creative. In problem-based learning, students participate in complex, life-like learning situations where they take the lead in gathering information, drawing conclusions, making decisions and simulating the processes of the world beyond their classrooms. Problembased activities may feature in a particular subject or learning area contexts or for periods of time for specific purposes rather than serves as the central instruction (Chin & Chia, 2005).

PBL engages students learning in ways that are similar to real world situations and assess learning in ways that demonstrate understanding and not mere replication. Students usually have misconceptions that can interfere with learning; problems can confront those misconceptions and help students look at things in new light. Students become more aware of their own understanding when they have to justify their decisions. The problem and solutions are meaningfully connected, so they are easier to remember (Domin, 1999; Smith, 1999; Greenwald, 2000). A PBL provides meaningful learning opportunity for students who can actively involve in their learning. In PBL, students construct the understanding through their experiences. Students active participate in the instruction and determine the direction of the instruction. The goals of the learners are defined by the learners themselves. They are motivated and they will take initiative in their learning.

CONCLUSION

Problem Based Learning (PBL) green chemistry vision are able significaly improve creative thinking skills greater (N-gain 0.71, high category) in the experimental class, higher than the control class (N-gain = 0.40). Increased creative attitude of students in solving environmental problems for classroom experiments including medium category, while the control class including low category. The student response to the implementation of environmental chemistry lecture-based vision problem developed Green Chemistry is very nice. It is seen also from: responsibility, hard work, perseverance, discipline, spirit of cooperation shown during the lecture student progress. Needs to be developed further research related to the assessment of creative attitude to various other instruments, such as observation and portfolios.

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