

THE EFFECT OF GREEN CHEMISTRY LABORATORY LEARNING ON PRE-SERVICE CHEMISTRY TEACHERS' ENVIRONMENTAL VALUE ORIENTATIONS AND CREATIVE THINKING SKILL

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Abstract: Environmental problems occurred in Indonesia, as one of developing countries, are challenging for young generation. Their positive behavior and creative thinking skill need to be developed in addressing these issues. Therefore, Chemistry Department of State University of Surabaya has introduced Green Chemistry approach in General Chemistry course as an effort to educate and prepare the future chemistry teachers become more awareness and concerned on the environmental condition. This study was preceded by the development stage to produce proper teaching materials. Hereafter, this paper investigated pre-service chemistry teachers' environmental value orientations, creative thinking skill, and profile of creative attitude after the implementation of Green Chemistry laboratory learning. Research findings showed that most of their environmental value orientations shifted considerably becomes less egocentric, more homocentric and ecocentric. This positive change hopefully will affect their behavior toward the environment. Generally, their creative thinking skill also increased significantly with the most dominant creative attitude during learning process was curiosity. It can be concluded that the Green Chemistry course was a suitable context of environmental education to support the development of more positive environmental value orientations. Also, creative thinking skill of pre-service chemistry teachers increased in leading the conceptualization of sustainable environment.

Keywords: *Green Chemistry Approach, Environmental Value Orientation, Creative Thinking Skill, Pre-Service Chemistry Teachers*

Abstrak: Permasalahan lingkungan yang terjadi di Indonesia sebagai salah satu negara berkembang menjadi tantangan generasi muda. Perilaku positif dan keterampilan berpikir kreatifnya perlu dikembangkan untuk mengatasi permasalahan tersebut. Jurusan Kimia Universitas Negeri Surabaya mulai memperkenalkan pendekatan Green Chemistry di perkuliahan Kimia Dasar sebagai salah satu upaya untuk mendidik dan menyiapkan mahasiswa calon guru kimia agar mempunyai kesadaran dan kepedulian yang lebih baik terhadap kondisi lingkungan. Penelitian ini diawali dengan tahap pengembangan untuk menghasilkan perangkat pembelajaran yang layak. Selanjutnya, penelitian ini menginvestigasi orientasi nilai lingkungan, keterampilan berpikir kreatif, dan profil sikap kreatif mahasiswa calon guru kimia setelah implementasi pembelajaran kimia berbasis laboratorium Green Chemistry. Hasil penelitian menunjukkan bahwa sebagian besar orientasi nilai lingkungan mahasiswa mengalami pergeseran secara signifikan menjadi kurang egosentris dan lebih homosentris dan ekosentris. Perubahan positif ini diharapkan dapat mempengaruhi perilakunya terhadap lingkungan. Secara umum, keterampilan berpikir kreatif mahasiswa juga meningkat secara signifikan dengan sikap kreatif yang paling dominan teramati selama proses pembelajaran adalah "curiosity". Berdasarkan hasil penelitian dapat disimpulkan bahwa pendekatan Green Chemistry merupakan konteks pendidikan lingkungan yang tepat untuk mengembangkan orientasi nilai lingkungan yang lebih positif. Selain itu, keterampilan berpikir kreatif mahasiswa calon guru kimia juga meningkat dalam rangka konseptualisasi lingkungan yang berkelanjutan.

Kata kunci: *Pendekatan Green Chemistry, Orientasi Nilai Lingkungan, Keterampilan Berpikir Kreatif, Mahasiswa Calon Guru Kimia*

I. BACKGROUND

Indonesia, as one of developing countries in the world, has been facing several environmental problems in recent time. It can not regardless from most of Indonesian people's awareness and knowledge on a sustainable environment which is still relative low. Most human activities related to the environment to fulfill their needs do not pay attention on the impact in

the future (Schultz and Zelezny, 2000). According to the data reported by the National Disaster Mitigation Agency (BNPB), the number of ecological disasters and climate change such as floods, landslides, and forest fires in a decade (2002-2009) is higher than the number of geological disaster such as volcanic eruptions, earthquakes, and tsunami. In addition, air pollution of industrial waste gases and transportation caused

Indonesia are in the third ranks as the country with the world's largest gas emissions that contribute to global warming (Measey, 2010). Thereby, the destructive human behavior is a key factor of the significant ecosystem degradation (Vlek and Steg, 2007).

Destructive behavior of society on the environment should have been the attention of all stakeholders, without exception practitioners of education. Teachers, as a major figure in learning process, should start to be aware of their important role in encouraging and influencing student interest as younger generation on environmental issues through the conceptualization of environmental problems and the development of cognitive framework regarding the environment (Teksoz, Sahin, and Ertepinar, 2010), in particular chemistry teacher.

Chemistry is closely related to human life. The role of chemistry is so great in helping improve the quality of human life, mainly in the social, industry, and economy (Udoh, 2012). Chemistry can be a tool of natural resources utilization in order to satisfy human needs. Yet, the process, production, and use of chemicals itself has caused some environmental problems, namely pollution, depletion of natural resources, and health problems. Therefore, these problems should be topics that deserve attention to be discussed and studied by students in connection with chemistry learning (Prodjosantoso, 2011).

In fact, chemistry learning is rarely connected to the relevant environmental issues (Prodjosantoso, 2011). It can be caused by teacher's knowledge about the environment is limited so the effectiveness of the implementation of environmental education programs in schools is low (Spiropoulou et al., 2007). Lack of teacher's knowledge about the environment has also impacted on the less responsible student behavior towards the environment (Pe'er, Goldman, and Yavetz, 2007). Additionally, student may not have a deep understanding about environmental problems though they have great attention to environment (Fien et al., 2002). Looking at the reality, prospective chemistry teachers should be equipped to have sufficient insight and knowledge about the environment in order to bring chemistry learning more relevant to the environment through the development of positive behavior and creative thinking skill.

Essentially, a positive behavior on the environment is deeply rooted in environmental value (Rokeach, 1973). In addition, Jonsson and Nilsson (2011) stated that environmental value can actually be internalized through learning process so that it becomes meaningful learning experiences. Then, it will be further developed into a hierarchy or priority level of some beliefs and norms that can guide someone in decision-making and behave toward the environment

(Stern, 2000).

Many types of environmental value orientations proposed by psychologists and even some the terms overlap each other. Therefore, the researchers determine the only three environmental value orientations that are the focus of this study, namely egocentric, homocentric, and ecocentric (Dietz et al., 2005). The three orientations perceived by researcher have represented the most basic determinant factor of attention and attitude toward environment. Egocentric orientation is a type of environmental values in a person who tends to be more individualistic and think only of their own interests rather than environmental conditions. Different from egocentric, homocentric considers environment as the basic of humanity. The last type of value orientation is ecocentric who value the environment as a unity of ecosystem that deserves attention as a whole. The intrinsic value of the environment would be the basis of ecocentric person to dedicate themselves to the environment. According to the result of Climate Change Conference held at Copenhagen in 2009, type of environmental value orientation that is really expected and needed in relation to recent environmental problems is ecocentric.

Based on the preliminary survey by administering the Questionnaire of Environmental Value Orientation among pre-service chemistry teachers at Chemistry Education, International Class, year 2014 in Chemistry Department of Unesa, only about 39.13% of them having ecocentric value orientation, 34.78% of them possessing homocentric value orientation, and 95.65% of them tend to be egocentric people. The number is certainly not consistent with the result of Climate Change Conference. In addition, the survey also indicated that pre-service chemistry teachers have not had a good insight to provide more relevant chemistry learning toward environment because egocentric orientation is still more dominant than homocentric and ecocentric orientations.

Creative thinking skill becomes one of the 21st century thinking skills that is expected had by every graduate education in Indonesia because of increasingly higher globalization demands. It is reflected on the Regulation Draft of the Minister of Education in 2013 on the National Standards for Higher Education states that academic education graduate of degree program are expected to apply the science and/or technology in their field of expertise through scientific reasoning based on logical, critical, systematic and innovative thinking. However, the result of preliminary survey by distributing the Creative Thinking Test among prospective chemistry teachers at International Class, year 2014 in Chemistry Department of Unesa showed that 82.61% of them were categorized "not creative" and 17.39% "less creative". Unfortunately, there had

not been prospective teachers of chemistry categorized having “creative” and “very creative” category.

Future chemistry teachers’ creative thinking skill can be grown up by learning the environment and current environmental issues, planning and designing an alternative sustainable (Daskolia, Dimos, and Kampylis, 2012). As suggested by Simmons (2000), creative thinking, as life-time skill needed for a meaningful learning, should be practiced in environmental education. It is because creative thinking supports a person involved in the completion of environmental problems towards a sustainable environment (Pruneau et al., 2006). Creativity is a tool that can be used by someone to empower themselves through a process of environmental education in order to gain a richer experience of the environment and actively participate and contribute in shaping the environment (Boeckel, 2009).

Chemistry teacher education at the university level gets a lot of attentions on some experts to introduce the various approaches that can enable educate future chemistry teacher to have positive behavior and creative thinking skill to bring chemistry learning more relevant and responsive toward the environmental conditions. According to, Dzulkifli (Esa, 2010), the university is a place where prospective teachers are trained to change the way of their teaching to affect their teaching methods when educating their students later. One way that can be applied to actualize prospective chemistry teachers’ positive behavior and creative thinking skill is through the integration of Education for Sustainable Development (ESD). ESD is an educational vision to introduce and apply sustainable development in an effort to develop the knowledge and skills needed for the nature sustainability in the future as well as change the value of orientation, behavior, and lifestyle through a holistic, integrated and interdisciplinary approach (UNESCO, 2009).

One approach that complies with three requirements of ESD is Green Chemistry. Green Chemistry approach is the application of chemistry to prevent pollution and reduce waste. Prevention of pollution through Green Chemistry emphasises on the use of materials and processes that can reduce and minimize the production of waste or pollutants. These include reducing the use of hazardous materials and protect the natural resources through the efficient use (EPA, 1990). According to Parrish (2007), Green Chemistry approach can encourage prospective chemistry teachers to learn how to cope with environmental problems because they are empowered to resolve these problems. Prospective chemistry teachers will be asked to use critical thinking skills, problem solving and communication ability to resolve those problems both locally and globally (Haack et al., 2005).

In practice, the application of Green Chemistry approach is based on the 12 principles (Anastas and Wagner, 1998). The principles of Green Chemistry are prevention, atom economy, less hazardous chemical synthesis, designing safer chemicals, safer solvents and auxiliaries, design for energy efficiency, use a renewable feedstocks, reduce derivatives, catalyst, design for degradation, real-time analysis for polluting prevention, and inherently safer chemistry for accident prevention. To understand each of these principles, pre-service chemistry teachers need to be introduced through an experiment process in laboratory.

Therefore, this study will be conducted in two stages, firstly the development stage to produce proper learning materials to support the learning process, secondly the implementation stage of Green Chemistry laboratory learning to change pre-service chemistry teachers’ environmental value orientations and to foster their creative thinking skill. Hopefully, it can raise their environmental knowledge and awareness to encourage them having more positive attitude and behavior toward the environment. Eventually, it may help them to design and provide more responsive chemistry learning toward the environment for students in their teaching career.

II. METHOD

This research was a pre-experimental study. In the pre-experimental study, experiments are conducted only on a single group without a comparison group (Creswell, 2012). The group was given a treatment during the study that is Green Chemistry laboratory learning. Furthermore, researcher investigated the effect of that learning toward pre-service chemistry teachers’ environmental value orientation and creative thinking skill, as well as observed their creative attitude. This study was preceded by the development of learning materials which consisted of lesson plans, student worksheets, and evaluation sheets.

The study was conducted during odd semester in academic year of 2014/2015. The location of research was International class of Chemistry Education, year 2014, Chemistry Department of Unesa. Target of the research was environmental value orientation and creative thinking skill of 23 pre-service chemistry teachers who studying General Chemistry at International class.

To collect the data, several research instruments were used in this study, such as the validation sheet of learning materials, the observation sheet of the enforceability of Green Chemistry Laboratory Learning, the evaluation sheets of learning achievement, the questionnaires, the journals, the sheet of creative thinking test, and the observation sheet of creative attitude.

The data regarding the validation of learning

materials, the enforceability of learning process, prospective teachers' learning achievement, and creative attitude were analyzed descriptively. Meanwhile, the data about prospective teachers' perception toward learning environment, environmental value orientations, and creative thinking skill were analyzed both descriptively and inferentially.

III. RESEARCH FINDINGS

A. The Validation Result of Learning Materials

Learning materials developed in this study were lesson plans, student worksheets, and evaluation sheets which were validated by validators. Table 1 presents the validation result of learning materials.

Table 1. The Validation Result of Learning Materials

Learning Materials	Aspects	Score	Category
Lesson Plans	Learning Objectives	4.43	Very Good
	Learning Activities	4.47	Very Good
	Time Allocation	4.33	Very Good
	Learning materials	4.59	Very Good
	Language	4.00	Good
	Learning Resources	4.50	Very Good
Student Worksheets	Instruction Aspect	4.33	Very Good
	Content Aspect	4.89	Very Good
	Green Chemistry Approach	4.43	Very Good
Summative test	Content	4.57	Very Good
	Language	4.47	Very Good
Creative thinking test	Content	4.50	Very Good
	Language	4.38	Very Good

Notes: Score interpretation of 4.21 – 5.00 is classified into “very good” category, while score interpretation of 3.41 – 4.19 is classified into “good” category. (Riduwan, 2010)

In general, lesson plans obtained very good category of validation. It indicated that the lesson plans were feasible to be implemented in the learning process to develop future chemistry teachers' environmental value orientations and creative thinking skill. The results were examined due to several factors. It could be shown from the sentence structure of learning objectives was composed operationally so it could describe behaviours that will be achieved by prospective teachers of chemistry as their result of learning achievement, as statement proposed by Gronlund (Arends, 2012). Also, lesson plan scenarios were believed helpful to promote pre-service chemistry teachers' orientation of environmental values and creative thinking skill.

This consideration of validator is in line with the result of past studies conducted by Mageswary et al. (2011) and Daskolia et al. (2012).

Overall, student worksheets used in this study obtained very good category of validation. The result indicated that this learning material was feasible to support the learning process. It can be represented from the content of student worksheets have emphasized on real-life application very well. This is influenced by the Green Chemistry approach applied into learning process. As stated by Braun et al. (2006), the Green Chemistry approach brings a connection between chemistry curriculum and daily life. By incorporating the approach, the content delivered to prospective teachers of chemistry was designed to cope with environmental problems faced in the daily life, for instance global warming and pollution of plastic bags and dangerous chemical substances contained in household cleaning product. Also, the content was considered in accordance with the current scientific development. This is because prospective teachers of chemistry were engaged into the new technology to make Green Chemistry products, such as biodiesel, bioplastic, and green cleaning products.

On the whole, the validation result indicated that all evaluation sheets could be effectively used as evaluation tools to measure the achievement of indicators that have been developed. Based on the content aspect, items of the assessment sheets have been formulated clearly and in accordance with the learning objectives developed. Additionally, instructions of doing test were clearly stated. Meanwhile, from the language aspect, the item has been formulated using a communicative sentences that can be understood well, according to Indonesian rules and contain no ambiguity.

B. The Enforceability of Green Chemistry Laboratory Learning

The enforceability of Green Chemistry laboratory learning is the observation result conducted by observers toward five components of Cooperative learning syntax used in the study during three meetings. First, opening section consists of giving motivation and clarifying learning objectives. Secondly, core section comprises presenting information, organizing pre-service teachers into learning groups, and assisting group to work and study. Third, closing section covers giving tests and providing recognition. Next, fourth and fifth aspects are observation of learning environment and time management.

The first component observed is opening section. In this section, pre-service chemistry teachers were given motivation by showing several environmental problems to them, such as global warming in the first meeting, plastic wastes for the second meeting, and hazardous chemicals from cleaning products at the third meeting, using both of video and slides power point. It aimed at engaging them to investigate more what is happening in the environment surround them. This

purpose is line with one of the statement proposed by Thelan (Arends, 2012) that the class should be a laboratory aimed at studying social problems, in terms of environmental destructions. The result of observation for this section indicated that observers gave very good criteria for second and third meetings.

Next to the second component is core activity. This activity consists of three phases, presenting information, organizing students into learning groups, and assisting teamwork and study. Overall, the first phase of core activity obtained very good criteria of assessment. In the first phase, before organizing pre-service teachers into learning groups, the lecturer introduced the Green Chemistry approach includes its 12 principles and the process of making biodiesel using waste vegetable oils at the first meeting, for the second meeting, lecturer presented topic of polymer and the process how to make bioplastic from banana peels based on Green Chemistry principles using video, and in the last meeting, pre-service teachers of chemistry were given information regarding Persistent Organic Pollutants (POPs) firstly, then were asked to pay attention on the process of making green cleaning products using slides of powerpoint. The purpose of these processes is to give them the basic knowledge of solving the problems in relation to chemistry concepts. Thus, the participants are expected to connect the content of learning with real life in terms of addressing environmental issues surround them, as stated by Braun et al., (2006).

Second phase of core activities is organizing the students into learning groups. For this phase, the lecturer is evaluated by observers very good in guiding the participants to join in their groups for doing their works, that is pre-laboratory sheet. It is aimed to give the participants an opportunity to learn and understand chemical concepts related to biodiesel, bioplastic, and green cleaning experiments. For instance, pre-service teachers should learn about transesterification reaction before conducting biodiesel experiments, should understand hydrolysis reaction of starch before doing bioplastic experiments, and should master the concept of acidity before exposing to green cleaning products.

The third phase of core activity is assisting teamwork and study. A very good assessment of this phase cannot be separated from the quality of learning materials used, that is, student worksheets. In this phase, pre-service chemistry teachers were working collaboratively and communicatively during completing all Green Chemistry experiments to make biodiesel, bioplastic, and green cleaning products guided by student worksheets which have been developed and validated in terms of instruction and content aspects, as well as suitability with Green Chemistry approach. In addition, the lecturer was assessed could manage the

classroom so it has been reflected a wider community life and learning laboratory in the real life, according to Dewey (Arends, 2012). Moreover, during the experiments, lecturer was observed giving assistance the participants in order to develop their thinking skills in solving problems occurred when completing the experiments. It is consistent to the statement proposed by Vygotsky (Slavin, 2011).

The third component is closing section. This section consists of two phases that is, giving test and providing recognition. Based on the observation result of observer, the process of giving test was evaluated with very good category. It means that the lecturer has been conducted as planned in the lesson plan and it is very clearly observed. Also, it is supported by several effective evaluation tools, which have been developed and validated in terms of language and content aspects. So, the test given to pre-service teachers were consistent with the goals and objectives of learning.

The fourth and fifth components are time management and learning environment. For time management, observer gave variety scores in range good and very good category.

The highest score was obtained in the second meeting. It is influenced by the process of making bioplastic which is simple and did not need too much time. So, the time allocation planned in the lesson plan could be implemented well. In contrast, the lowest score was given in the first meeting. The factor is related to the process of making biodiesel which is needed more time, particularly when glycerol and crude biodiesel formed. So, the lecturer got some difficulties to manage the time allocation for experiment and discussion in the first meeting.

Observation of learning environment is relied on enthusiasm of the lecturer and the students as well as whether the learning process can represent student-centered approach or not. The result, indicated that enthusiasm, both of the lecturer and the students, during the learning process were assessed in range of very good criteria. In addition, the learning process was evaluated as student-centered approach by the observers in very good category as well. It is also reflected and consistent with the result of reflective journals.

C. Pre-service chemistry teachers' Learning Achievement

Laboratory learning environment, used in this study, leads to focus of pre-service teachers' learning achievement not only on cognitive aspect, but also affective and psychomotor aspect. The combination of three kinds of assessment aspects should be considered in assessing student's ability in chemistry, mainly laboratory activities (Hofstein, 2004).

1. Cognitive Learning Achievement

Cognitive aspect was assessed using summative test, given after the learning process conducted. This evaluation sheet consists of 14 essay questions used to measure the mastery of ten indicators. Figure 1 provides the analysis of indicator mastery.

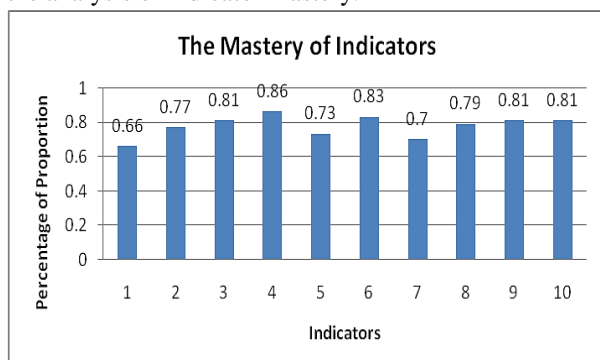


Figure 1. The Result of Indicator Mastery

Based on score conversion standard at Unesa, year 2014/2015, an indicator is categorized “mastered” if the proportion of right answers achieves more than 55%. In the Figure 1, from ten indicators, pre-service teachers successfully mastered all. It was shown from the mastery of indicators was ranged between 66% until 86%. It means that Green Chemistry approach applied in the laboratory learning environment could assist pre-service teachers to achieve whole indicators well. This result is line with the study conducted by Aladejana and Aderibigbe (2007) that science laboratory learning environment is determinant factor of student’s learning achievement in the science learning, in terms of chemistry. Besides, the achievement of pre-service teachers’ cognitive aspect was also supported by the quality of evaluation tools used to measure achievement of all indicators developed, that is, summative test. It has been assessed in terms of language and content aspects, so it can be used easily by the participants.

2. Affective Learning Achievement

Affective aspect measured in this study is social skills, include, collaboration and communication. This aspect was assessed by five observers using the observation sheet of social skills. Figure 2 illustrates the result of affective learning achievement clearly.

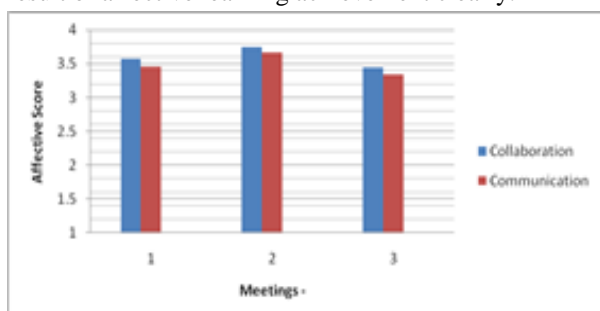


Figure 2. The Result of Affective Learning Achievement

Figure 2 above showed that two indicators obtained generally very good category. It proves that Green Chemistry laboratory learning using Cooperative learning model has been conducted well by lecturer, so it could support the development of pre-service chemistry teachers’ social skills, in terms of collaboration and communication (Binkley et al., 2012), since they were given opportunities to understand each other through group activities, such as doing experiments and discussion. It is reflected from the result of enforceability of Green Chemistry laboratory learning, particularly when lecturer organized students into learning groups and assisted their teamworks and study, these phases obtained very good category. Also, it is line with previous study conducted by Ghosh (Mitakidou and Tamoutseli, 2011) found that Cooperative learning model is one of the best methods to apply of ESD system through Green Chemistry approach.

3. Psychomotor Learning Achievement

Psychomotor skills of pre-service chemistry teachers in using laboratory equipments when conducting Green Chemistry experiments were measured using the observation sheet of psychomotor skills. The mastery of psychomotor skills comprises the skill of weighing the mass of NaOH using balance and measuring the volume of vinegar using graduated cylinder. Figure 3 visualizes the result of psychomotor learning achievement in detail.

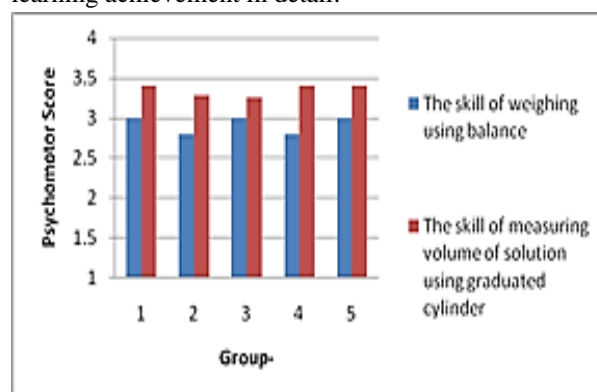


Figure 3. The Result of Psychomotor Learning Achievement

In Figure 3, the psychomotor skills predominantly obtained good and very good category of assessment. From two of indicators measured, pre-service teachers of chemistry were generally more mastered to measure the volume of vinegar using graduated cylinder than to weigh the mass of NaOH using balance. It shows that learning activities in the Green Chemistry laboratory learning have supported prospective teachers’ performance when doing experiments, so that it influences their psychomotor skill to use available laboratory equipments (Riyanti et al., 2013).

D. Pre-service Chemistry Teachers' Perception of the Green Chemistry Laboratory Learning Environment

Pre-service chemistry teachers' perceptions toward Green Chemistry laboratory learning environment refers to a response, feeling, and opinion perceived during participating into the learning process (Dochy, 2005). The perceptions were assessed using a questionnaire, namely Chemistry Laboratory Environment Inventory (CLEI), distributed after the learning process finished. There are six scales contained in the questionnaire, namely student cohesiveness, open-endedness, integration, rule clarity, material environment, and scale of Green Chemistry course. The detail result of their perception is presented in Figure 4.

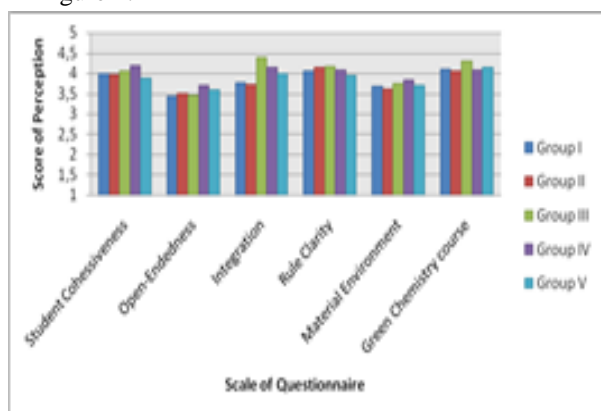


Figure 4. The Result of Perception of the Green Chemistry Laboratory Learning

Based on the result, all pre-service teachers exhibited positive perceptions toward Green Chemistry laboratory learning environment. Evidently, six aspects of the questionnaire obtained good and very good category of assessment. It means that they perceived the learning process in such learning environment supported all interactions happened in the class, such as interpersonal interaction between pre-service teachers, pre-service teachers with lecturer, pre-service teachers and learning materials, tools and materials for experiments, as well as with learning strategy (Hofstein and Lunetta, 2004). The most positive perception was given by pre-service teachers to the last scale, that is, Green Chemistry course. It implies that the approach was able to support the learning process in the context of environmental education through introducing Green Chemistry principles into laboratory activities.

E. Pre-service Chemistry Teachers' Environmental Value Orientations

The data regarding pre-service chemistry teachers' orientations of environmental value was gathered using the Questionnaire of Environmental Value Orientation and Journals. The questionnaire and journals were administered twice, before and after the learning process.

1. The Results from Questionnaire

In this study, Wilcoxon's signed rank test is used to analyze whether the Green Chemistry laboratory learning which have been implemented could give positive effect on pre-service chemistry teachers' environmental value orientations. There are three kinds of environmental value orientation examined in this study, that is, egocentric, homocentric, and ecocentric. The result of Wilcoxon's signed rank test is presented concisely in Table 2.

Table 2. The Result of Wilcoxon's Signed Rank Test toward Environmental Value Orientation

	Egocentric		Homocentric		Ecocentric	
p-value	0.000	H ₀ rejected	0.000	H ₀ rejected	0.001	H ₀ rejected

Table 2 showed that the learning process conducted had a positive effect on decreasing pre-service teachers' egocentric orientation significantly as well as increasing pre-service teachers' homocentric and ecocentric orientations significantly. This effect is really tied to the internal strength of learning process. This statement is proven from the change of environmental value orientation is not the result of pre-service teachers' perception toward the learning environment. Empirical evidence of this statement is the result of analysis of the relationship between environmental value orientation and pre-service teachers' perception toward the learning environment using Chi-square test shown in Table 3.

Table 3. The Result of Chi-Square Test toward Relationship between Environmental Value Orientation and Perception toward Green Chemistry Course

	Egocentric		Homocentric		Ecocentric	
p-value	0.003	H ₀ rejected	0.075	H ₀ accepted	0.484	H ₀ accepted

Indeed, it can be stated that the changes in environmental value orientations of prospective chemistry teachers were due to their enrolment in the Green Chemistry course.

2. The Results from Journals

To better understand the change of each of environmental value orientation, the more-depth data from the journals was used to support quantitative data, gained through the questionnaire. The journals used in this study consisted of two kinds, initial and reflective journals.

While writing both the journals, the participants in the Green Chemistry course, were asked to express their concerns on environmental protection occurred nowadays. Then, their responds to the questions were transcribed and the changes in environmental values of the pre-service teachers from the initial to the reflective journals will be revealed. The transition matrix in Table 4 illustrates the change in environmental values of pre-service teachers between initial to reflective journals.

Table 4. Transition matrix for the change between value orientation before and after the Green Chemistry laboratory learning

	AFTER					Σ before
	Ego	Ego/ Homo	Homo	Homo/ /Eco	Eco	
B						
E	Ego			2	5	7
F	Ego/ Homo			2		1
O	Homo			3	2	2
R	Homo /Eco			1		1
E	Eco				5	5
Σ after			8	12	3	

From the matrix above, before Green Chemistry class, seven of pre-service chemistry teachers still exhibited egocentric value orientation and three of them reflected combination between egocentric and homocentric orientations. Whereas, after involving to the learning process, none of the respondents expressed egocentric orientation anymore. For homocentric value, before the course, a total of seven participants reflected only homocentric value in particular, while combination homocentric and ecocentric orientations were only exhibited by one prospective chemistry teacher. Surprisingly, after being introduced by Green Chemistry experiments, a total of 12 respondents possessed the discourse of combination between homocentric and ecocentric values and participants who expressed only homocentric became eight people.

The last, ecocentric value orientation was exhibited by five prospective teachers of chemistry prior to Green Chemistry course, while after the course, the number of them decreased since it shifted to combination homocentric and ecocentric value orientations.

Meanwhile, the change in egocentric become ecocentric value orientation were not reported from in the journals. Overall, the result of change of environmental value orientations exhibited from journals indicates that considerable shifts from egocentric toward homocentric value.

F. Creative Thinking Skill

In completing the environmental problems, creative thinking can be a tool used to support and empower people involved entirely towards a sustainable environment (Pruneau et al., 2006). Therefore, this study not only focuses on changing pre-service teachers’s environmental value orientations in respond to address environmental problems, but also concerns on enhancing their creative thinking skills by introducing Green Chemistry approach.

To analyze it, Wilcoxon’s Signed Rank Test was used to find out the result. p-value obtained is 0.000. It means that the learning process conducted had a positive effect on raising pre-service teachers’ creative thinking skill significantly.

For more detail, Figure 5 illustrates the result of creative thinking test at pre test and posttest.

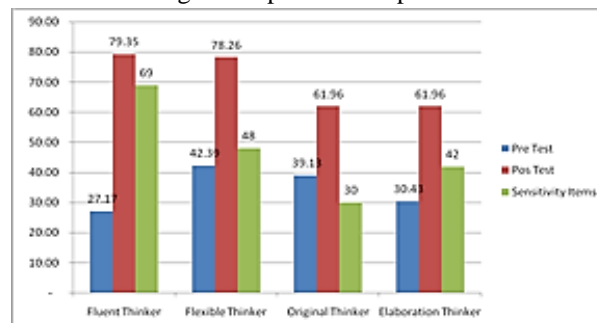


Figure 5. The Pretest, Posttest Result and The Sensitivity Items of Creative Thinking Test

The data above shows that the score of pre-service chemistry teachers’ creative thinking test increased generally. The category of creative thinking skill changed mostly from not creative becomes creative. The result proves that Green Chemistry laboratory learning had successfully fostered pre-service chemistry teachers’ creative thinking skill after they participated within.

Those explanation in above is also supported by empirical study from Daskolia et al. (2012), context of environmental education has positive influence toward student’s creative thinking skill since students are able to participate actively in the learning process by joining in learning group, to learning by doing through collaboration learning, and engaging in real-life problems using problem-solving environmental problems. These kinds of learning activities have been covered in the third and fourth phases of Cooperative learning model used in this study. Pre-service teachers were involved into several learning groups to carry out three Green Chemistry experiments, such as biodiesel, bioplastic, and green cleaning product as an alternative solution to cope with environmental problems related. Furthermore, the experiments conducted by pre-service teachers were designed as safe and environmentally friendly process because of the implementation of Green Chemistry approach. Prospective teachers were then involved into discussion of group and class to discuss several questions related to an article of environmental problem related to Green Chemistry product which has been made. These questions were composed based on the four aspects of creative thinking.

G. Profile of Creative Attitude

The enhancement of creative thinking skill as a result from the effect of Green Chemistry laboratory learning cannot be separated entirely from creative attitude that pre-service teachers have. Lee (2005)

argues that creative behavior may not be generated if children fear new thinking or do not want to be creative. In other words, creativity, as process of thinking, is tied with the desire for personal expression in terms of the behavior exhibited (Piiro, 2012). In relation to it, Williams (Munandar, 1999) proposes that to investigate easily whether someone is categorized as creative people or not, it can be indicated from the characteristic of creative thinking skill related to aptitude and non-aptitude elements.

For this purpose, researcher decided to use three aspects of the non-aptitude element for creativity, namely curiosity, tolerance for ambiguity, and risk taking (Proctor and Burnett, 2004; Piiro, 2012). The reason for choosing those aspects is because the aspects represent four aptitude elements of creative thinking skill that is, a fluent, flexible, original, and elaboration thinker used in this study. A fluent thinker is linked to curiosity. If person can generate a lot of ideas or answers about certain problem, it is assumed that they have high curiosity. Attitude of a tolerance for ambiguity is associated to flexibility. Someone who can think flexible, it means that they have high tolerance for ambiguity. The last aspect for creative attitude is risk taking refers to dear to think new, unique, unusual, as well as complicated. Therefore, this aspect is connected with original and elaboration thinker. All aspects of creative attitude were integrated in all learning activities, both of experiments and discussion.

The data collection of creative attitude in this study used observation method. Figure 6 visualizes clearly the profile of creative attitude during the learning process.

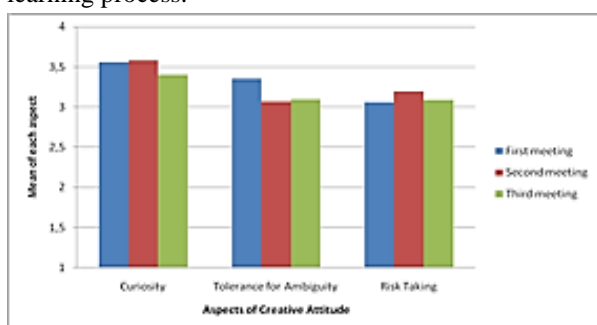


Figure 6. The Profile of Future Chemistry Teachers' Creative Attitude

The result reported in Figure 6 showed that aspect of curiosity was the most dominant creative attitude observed during the learning process, then followed by aspects tolerance for ambiguity and risk taking. This result is actually consistent with the increase of creative thinking skill. Evidently, the highest enhancement of creative thinking skill was experienced by a fluent thinker and it is tied with aspect of curiosity as the most dominant creative attitude observed. Meanwhile, the lowest enhancement of creative thinking skill was

exhibited by an original thinker and it is tied with aspect of risk taking as the least dominant creative attitude observed. To sum up, the result of this study regarding to the pre-service teachers' profile of creative attitude is relevant with the statement proposed by Piiro (2012).

IV. CONCLUSION

A. Knot

Based on the whole description regarding research findings, so it can be concluded that the implementation of Green Chemistry laboratory learning was supported by proper learning materials developed in the initial stage of this study. So, it could be conducted well by the lecturer, represented from the result of enforceability of the learning process, pre-service teachers' learning achievement, and perception toward the learning environment. Therefore, it could give positive effects significantly on the development of more positive environmental value orientations and creative thinking skill for pre-service chemistry teachers towards more positive behavior and awareness in leading the conceptualization of sustainable environment.

B. Suggestion

Because of the main focus of this study is only how environmental value orientations affect people's thinking to act and behave toward the environment, so it is recommended for further researches to investigate and observe directly the change in attitude and behavior as well, as the result of better environmental value orientations possessed.

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