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Improving Student Creative Thinking Skills Through Project Based Learning

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Abstract

The purpose of this study is to improve the ability to think creatively, make pyrolysis devices and make fuel oil from plastic waste. This research is a classroom action research conducted in 3 cycles with the stages of each cycle which includes 4 stages, namely observation, process, observation and reflection. The research subjects were students of class XI IPA 3 SMA Negeri 14 Semarang as many as 34 people who entered 12 sons and 22 girls. Data collection uses test instruments and measurement of creative thinking abilities and student response questionnaires. The data were analyzed descriptively and from the results of research that showed fluency, flexibility, originality, and elaboration after the application of hydrocarbon and petroleum learning. The results show that the average way of thinking of students is in the creative predicate.with a high increase in each indicator of fluency and elaboration

Keywords: creatively; project-based learning; classroom action research.

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1. Introduction

At this time in every learning in school, the teacher has a new challenge that is equipping students with 21st century skills that aim to prepare students to become successful individuals in life. Chemistry learning is no exception. Chemistry learning is expected not only to be oriented to memorizing concepts, but also to develop students' intellectual abilities to adapt to different conditions, respect society, and be tolerant of ideas (Aktanis & Yenice, 2010).

Important skills in the 21st century contain special skills that need to be empowered in learning activities, namely high-level thinking skills such as critical thinking and creative skills, problem solving, metacognition, communication skills, collaboration, innovation, creation, and information literacy (Zubaidah, 2016; Heong et al., 2011). One of the 21st century skills that can be developed through chemistry learning is creative thinking skills (Hadzigeorgiou et al., 2012). The ability to think creatively is a mental process that is used by individuals to bring new ideas, new insights, new approaches, new perspectives and new ways to understand various things (Eragamreddy, 2013; Birgili,

2015; Forrester, 2008). Creative thinking will bring creativity and make students have many ways to solve problems with different perceptions and concepts (Kutlu, 2015; Risnawati & Saadi, 2016).

Some things that cause in chemistry learning, students' creative thinking skills are still not well developed. First, the teacher does not know the right way to increase students' creativity in the learning process in the classroom (Laius & Rannikmae, 2014; Cheng, 2010); Second, this ability is too difficult if applied to students who have limited knowledge and thinking skills (Cheng, 2010). Third, schools lack access to students to develop their ability to think independently. Fourth, the learning process in schools emphasizes unproductive thinking, focuses on memorization and looks for one correct answer to the questions given (Risnawati & Saadi, 2016). This will certainly result in the inhibition of students' creativity.

The implementation of the 2013 curriculum in various schools has experienced many obstacles due to several different factors. Based on the results of interviews with several chemistry teachers in the city of Semarang, the 2013 curriculum has been implemented in schools, but not yet optimal. The scientific approach as a curriculum demand has not been implemented well because teachers have not been skilled in applying scientific approach learning models, both Inquiry / Discovery Based Learning, Problem Based Learning and Project Based Learning. Thus the 21st century skills that should be provided to students have not yet materialized.

The results of the preliminary tests conducted on 64 high school students in the city of Semarang related to the ability to think creatively, showed only a small percentage of students (± 29%) were in the criteria of very creative and creative. In general, students are in sufficient and less creative criteria based on 4 aspects of creative thinking skills (Table 1). The results of observations on students' creative thinking skills at the time of learning, it turns out that from the four aspects of creative thinking skills, namely fluency, flexibility, originality and elaboration, only the fluency aspect is prominent which is when asking and answering the teacher's questions.

Table 1: Results of analysis of students' creative thinking skills.

Indicators of creative thinking skills	Less creative (%)	creative enough (%)	Creative (%)	Very creative (%)
Fluency	23	45	27	5
Flexiblity	25	43	22	8
Originality	38	47	15	0
Adaptation	15	48	30	7
Source: results of field studies				

According to Agustina & Noor (2016), someone who has a high level of creative thinking, their learning outcomes will be satisfying. This is because with the ability to think creatively, people will have a fast way of thinking, be superior in thinking and find solutions to the problems they encounter. If it is associated with the results of learning observations carried out by the teacher, the likelihood of low students' creative thinking skills is due to the teacher having no experience in practicing creative thinking by integrating it into the learning he does (Cheng, 2010). According to Cheng (2010) developing creative thinking can be done through scientific processes, science content and science learning scenarios. Therefore, to overcome the problems related to the low creative thinking skills of students, so in this action research is applied one of the scientific approach learning models namely project-based learning which is suspected of being able to improve creative thinking skills (Sumarni, 2015).

Project-based learning is one of the scientific learning models that gives students the freedom to plan learning activities, carry out projects collaboratively, and ultimately produce work products that can be presented to others (Sumarni, 2018; Yalçin et al., 2009). Unlike conventional learning models, the teaching and learning process in project-based learning is more geared towards student-centered learning, involving students in learning knowledge and skills through developing inquiry processes to obtain products (Sumarni et al., 2016; Widiyatmoko & Pamelasari, 2012), acting teachers as a facilitator and motivator, and in addition to seeing learning outcomes also emphasizes proportional process skills. This learning is learning that requires teachers and / or students to develop guiding questions. Thus, the project-based learning model can theoretically influence student learning outcomes and levels of creativity.

Project-based learning steps are carried out through a project within a predetermined time period with steps that include preparation / planning, implementation, reporting and communicating the results of activities and evaluations. Through project learning, there is the development of an inquiry process in learning topics that are real in nature so as to attract students to study. This is also supported by research results which show that project-based learning models in addition to motivating students to learn material that exists in everyday life can also enhance creativity (Tiantong & Siksen, 2013; Thomas, 2000; Bell, 2010; Yalçin et al., 2009), improves creative thinking skills (Fatmawati, 2011; Lindawati et al., 2013), improves student performance (Akinoglu, 2008; Yalçin et al., 2009) and is able to facilitate students to gain high cognitive abilities (Rati et al., 2017). Therefore, it is felt appropriate to apply the project-based learning model (PjBL) which has been empirically proven to be able to improve this creative thinking skills in students who are still low in creative thinking skills.

Based on the things that have been said above, then to overcome the problems related to the low creative thinking skills of students of class XI 3 of SMA Negeri 14 Semarang, project-based learning models have been applied on hydrocarbon and petroleum materials with the project task of making pyrolysis equipment and distillation to process waste plastic into fuel oil. The formulation of the problem in this action research is how to increase students' creative thinking skills after the application of project-based learning with the project task of making a distillation pyrolysis device to process plastic waste.

Thus the purpose of classroom action research is to improve the creative thinking skills of class XI IPA 3 students through the application of project-based learning.

2. Methodology

The study used a classroom action research design (classroom action research) which was carried out in 3 cycles. Each cycle consists of 4 PTK phases including action planning, action implementation, observation and reflection.

The first phase is Action Planning, this phase the teacher plans the actions to be taken in the research, both in the form of learning strategies to the tasks that will be given to students. The second phase of the Action Implementation, where the research is carried out according to what was planned. The difference in actions that occur in each cycle depends on the results of reflection in the previous cycle. The third phase is observations carried out throughout the learning process in this study by recording every activity carried out by the teacher and students. While the fourth phase is Reflection. This phase is carried out based on the data obtained during and after the action to analyze its deficiencies and strengths. These four steps are reflected in the final step in a collaborative and participatory manner so that actions can be improved to achieve the expected student learning outcomes.

This action research was carried out at SMA Negeri 14 Semarang, Central Java. The research subjects were students of class XI IPA 3 in the odd semester of 2018/2019 school year with 34 students, consisting of 12 male students and 22 female students. The topic of discussion used in the provision of action is hydrocarbons and petroleum with the project task of processing plastic waste into fuel oil by pyrolysis and distillation.

Data Collection Instruments in the form of observation sheets aspects of creative thinking skills used by observers and test instruments that students must answer by expressing their thoughts narratively (Thinking Creatively with Words) (Runco et al., 2010). Aspects assessed to measure creative thinking skills with words refer to the

assessment conducted by Torrance (1981). Data analysis techniques carried out in this study are by calculating the number of scores obtained by students in each aspect.

The indicator of success in this action research is if the ability of students to think creatively classically in each aspect reaches 75% with a minimum of creative predicate.

3. Results and Discusion

3.1. Description of the way of classroom action research

Based on the results of the discussion between the research team, planning was carried out for action in solving problems. Learning refers to PjBL syntax starting with determining essential questions, planning projects, arranging schedules, monitoring and evaluating throughout the project, and ending with the completion of project assignments, namely processing plastic waste using a simple pyrolysis tool. In addition to being a means of enhancing students 'creativity, this project also has an impact on increasing students' conceptual understanding of hydrocarbon material and its application in daily life, especially in relation to fuel oil. In this learning four or five students from different levels of ability group to improve their understanding (Odwan, 2012). This simple pyrolysis equipment manufacturing project has begun in cycle 1, namely the project design stage, the manufacturing phase, and the testing phase of the tool.

In the implementation of the action, the project work begins with the design of pyrolysis equipment and plastic waste distillation with waste materials, such as used cans, used bottles and hoses, followed by the practice of arranging tools and trying tools to obtain distillate in the form of fuel oil. Processing plastic waste into fuel oil uses pyrolysis and distillation methods.

At the design stage of the project task, students present the results of the design of the tool in the form of components, the function of each component and predict the results if implemented. Students in groups also discussed the selection of tools and components of the components in the pyrolysis device so that students understand the components of the pyrolysis device and its functions. This is done to equip students' creative thinking skills. While during the implementation of the practice of separating fuel oil from plastic waste with a pyrolysis device that has been designed, students also discuss and present related successes and failures of the trial design and try to reflect on its successes and failures. For groups that have failed to be strived to keep trying

to achieve success. In every activity carried out by students, it is always followed by observing their creative thinking skills.

3.2. Description of student creativity improvement

From studies that have been carried out from pre-cycle, cycle I to cycle III obtained positive results data compared to Figure 1.

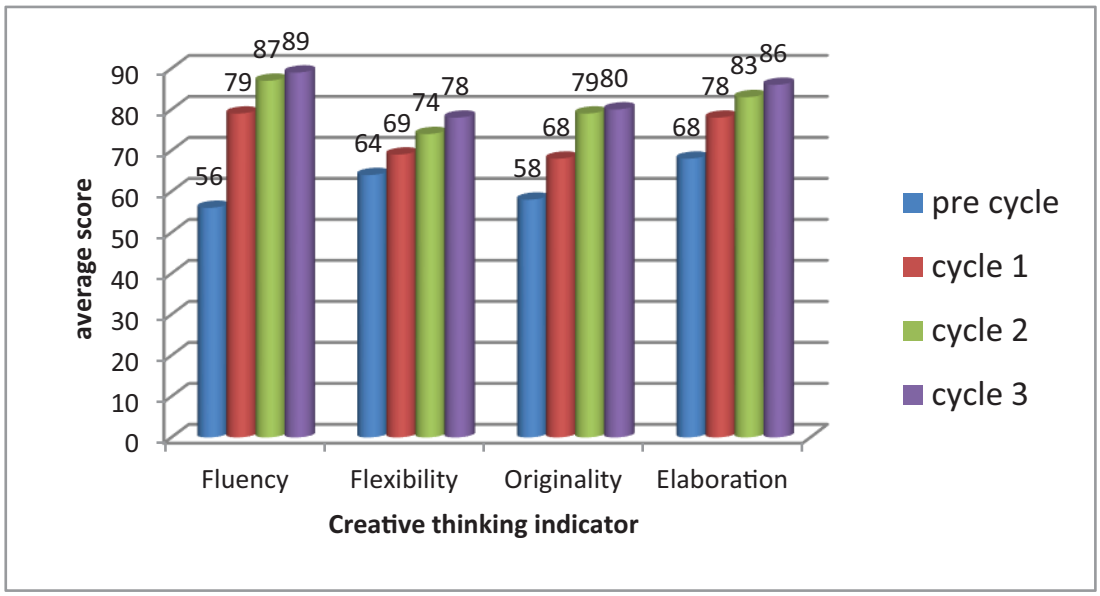

Figure 1: Increase in the average creativity of students from pre-cycle, cycle I-III.

From Figure 1 it can be seen that students' creative thinking skills in the fluency and originality aspects increased from the less creative categories in pre-cycle, increased in the creative predicate in cycle 1, and increased again in cycles II and III with creative predicates with higher grades. In the aspect of flexiblity which was originally in the predicate quite creative in pre-cycle, it has not experienced an increase in the first cycle, and only experienced an increase in cycles II and III with a creative predicate. In the elaboration aspect, which was originally in the pre-cycle, the predicate was quite creative, in the first, second and third cycles, it has increased in the creative category.

When viewed from the initial conditions of students (pre-cycle conditions) it appears that students' creative skills are still relatively low, which is less creative in aspects of fluency and originality, and quite creative in aspects of flexibility and elaboration. This shows that the learning that has been carried out by teachers generally lacks students' creative thinking skills, although creativity should need to be developed early because it is expected to be a stock in dealing with life's problems (Liliawaty, 2011). The results of observations conducted by Liliawaty (2011) of the four aspects of creative thinking skills,

only the apparent fluency and frequency is very small from all the number of students in one class, only about 8% show this. The results are also in accordance with the results found by Widiyatmoko and Pamelasari (2012) which state that initially students tend to experience difficulties in developing creativity, in addition to being unfamiliar with the learning received by students not yet equipped with critical thinking skills because they tend to be teacher centered, memorizing concepts, and less applicative to overcome life's problems.

From the results of the study, it can be seen that people who are very creative, have started working on a project based on cycle 1. The results obtained in the research that are in accordance with what ChanLin (2008) said was used to increase creativity. student. Increased creativity, because PjBL can increase students 'motivation to learn, students can directly identify what is in everyday life through project development, and can increase students' knowledge and creativity abilities. In searching for projects, students are also required to conduct discussions with groups related to the problems involved in distilling plastic waste. This discussion process can improve an effective process (Kwok & Lau, 2015), and from this process the course will help students to solve problems innovatively (Razzouk & Shute, 2012).

The results of the reflection of learning cycle 1 were found in general from four aspects that did not meet the specified performance indicators, namely 75% of students had achieved a minimal creative predicate. The aspects that have not been purchased are flexibility and originality. Thus the research continues into cycle II. The results of the reflection of the second cycle show that there are positive aspects of the employment indicator, namely> 75% of students have achieved a minimal creative predicate. Because at this stage this happens from the tasks that students do not all have succeeded, then the process still goes to cycle III. The implementation of cycle III is in addition to the results obtained in cycle II, also to improve creative indicators.

The results of the reflection of cycle III show that the achievement of creative thinking skills still achieves a very creative predicate, only with a higher value than the results of cycle II. This shows that project-based learning has not been able to improve creative thinking skills to achieve a very creative predicate. Nevertheless, overall at the end of the third cycle all students have successfully improved their creative thinking skills. This result as stated by Widiyatmoko and Pamelasari (2012) supported by Deta (2013) shows that PjBL as an innovative learning with pyrolysis and distillation props products can increase students' creativity because this learning emphasizes contextual learning through complex activities that provide opportunities for students to use the units of daily life as learning material.

3.3. Description of the increase in each indicator of creative thinking skills

The improvement of creative thinking skills in each cycle is also analyzed on the indicators of each aspect. The results of the analysis can be seen in Figure 2.

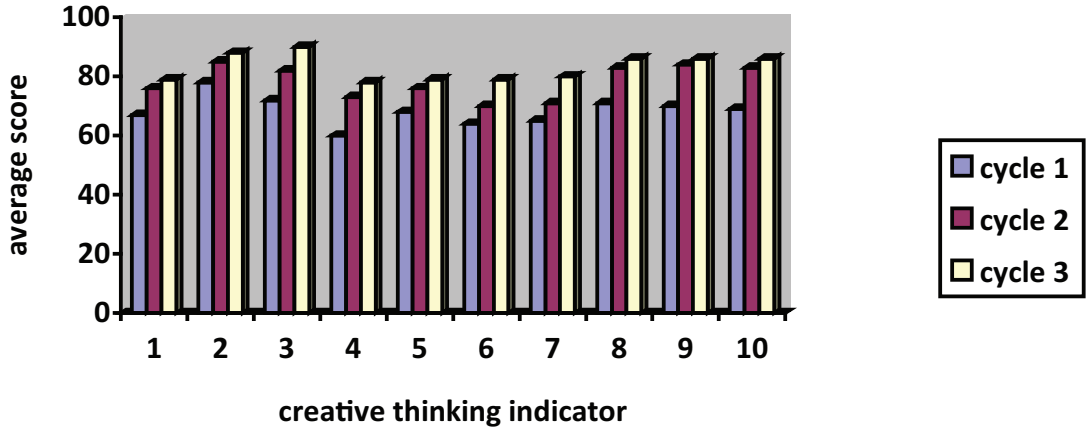

Figure 2: Student Project Assessment Results from Cycles 1-3. (**Description: 1) many ideas, 2) provide many ways, 3) work faster, 4) vary answers, 5) see a problem from a different perspective, 6) new ideas, 7) spark ideas, 8) enrich ideas others, 9) detailing an idea, 10) having a justifiable reason**).

Based on Figure 5, it can be seen that in all indicators of creative thinking skills that are considered to have increased in each cycle after the application of project-based learning with the project task of making pyrolysis and distillation of plastic waste into fuel oil.

In the first cycle, all indicators of creative thinking skills are fairly creative, except indicator 4 produces ideas for problem solving or answers to a variety of questions in the less creative predicate. The results of reflection on cycle 1 found that there were still many weaknesses in the learning model that was applied especially in project tasks that students had to do. Weaknesses encountered include lack of understanding of students in paying attention to explanations from teachers; the ability of students to come up with ideas, suggestions, questions, ideas, or alternatives answers not yet smooth; students are not used to compiling project designs based on literature studies and observing shows on youtube; students are not yet used to preparing practical tools and materials independently.

The results obtained at the end of cycle I, in accordance with the statement expressed by Osuala & Onwuagboke (2014) that for mastering aspects of creativity, especially in aspects of planning activities and assembling tools are still low, and the ability to bring ideas, ways, suggestions, questions, or ideas too still low and not yet varied. This happens because 1) students are unprepared in participating in the lesson, 2) students

are not yet ready to conduct independent experiments, 3) students have not been trained continuously to master the four activities of creative thinking skills, 4) constraints of face-to-face time in previous encounters so that after doing learning cycle I students are considered to have mastered the activities of creative thinking skills, 5) the role of the teacher that is less than optimal involves students to develop their thinking skills,

Based on the results of the reflection conducted at the end of cycle 1, collaborative improvements have been made to the design of the cycle II learning program. Changes in the implementation of cycle II learning compared to the first cycle, namely in the preparation stage is carried out with a discussion of the components of the distillation equipment that has been brought along with its function in distilling plastic waste, ending with a presentation. This activity is also a means to equip all four aspects of creative thinking skills. Activities carried out in cycle II turned out to have a positive impact on students' creative thinking skills.

The results of the analysis of students 'creative thinking skills after implementing cycle II learning showed all indicators of students' creative thinking skills experienced a significant increase in the creative predicate (Figure 5). In Figure 5 there is a high increase in all fluency and elaboration aspect indicators. At the end of the second cycle, the ability of students to generate ideas / ideas, enrich the ideas of other friends, implement these ideas with much more accountable reasons, and work faster than those produced in cycle I. The results also show that the value of fluency and elaboration is faster for students than the other two aspects. This is consistent with the findings of Akinoglu (2008) indicating that PjBL is effective in improving student performance and creativity through product creation, because during the process of making the product, students use their thinking skills and imagination to think smoothly.

A not too large increase occurs in the indicators of originality aspects and one aspect of flexibility indicators. The ability of students to provide new ideas, ability to carry out their ideas, and the ability to see a problem from a different point of view are in a pretty creative predicate. The results of the reflection cycle II found that the implementation of learning with project assignments had proceeded as expected. Indicators of success have been achieved, namely at least 75% of students have obtained creative and very creative predicates. However, because the score of creativity obtained has not been maximized and there are very few students who are very creative predicates, the implementation of the cycle is still continued to sharpen the results obtained in cycle II.

In Figure 5 also seen, a fairly high increase occurred in the originality and fluency aspects of the third cycle, namely working faster and doing more than others who were included in the creative criteria with a higher score compared to the results of cycle

II. In this aspect students have been smooth and agile in assembling the distillation apparatus correctly and correctly, and are able to modify several different components of the previously designed series of pyrolysis and distillation devices. All pyrolysis devices made by students have been successfully used to process plastic waste into fuel oil. This is consistent with the findings of Widiyatmoko and Pamelasari (2012) and Hakimzadeh et al. (2013) which states that in the early stages students usually experience difficulties in producing and modifying teaching aids. But after getting used to, the students are more fluent in doing everything. This shows a better improvement in creative thinking skills in cycle II. In the first indicator, the fluency of students has been able to provide many answers with a very diverse and flexible (flexibility). In addition, all groups of students, have the confidence and courage to give different answers from their peers and can spark ideas for solving a problem and can implement it correctly.

At the end of the third cycle, it is also used as a means of final evaluation of the products of pyrolysis and distillation tools that have been made by students. In contrast to the results of the first cycle and second cycle projects, most students have not succeeded in the practice of plastic waste pyrolysis, in practice in the third cycle most students have been fluent and skilled in assembling and successfully carrying out pyrolysis and distillation of plastic waste into fuel oil. In Figure 5 also observed an increase in other indicators in the third cycle is not too large. This is according to what is expressed by students who are continuously trained will experience experience in performing complex skills, helping students develop creativity, thus forming positive learning skills (Sumarni, 2015; Mardapi, 2012).

The results that have been obtained through this action research prove that through project learning there is the development of an inquiry process in learning real-world topics so that it attracts students to learn. PjBL has provided a variety of experiences inside and outside the classroom that shape participation in the democratic process: collaboration, listening to and responding to each other's ideas, coordinating the different efforts and contributions of members and all subgroups, resolving disputes and understanding how to solve problems and completing tasks and so on This is in line with the opinion (Tiantong & Siksen, 2013) which says that the application of project-based learning models is effective in increasing students' knowledge and creativity.

Project-based learning as already implemented is interdisciplinary learning in building conceptual understanding that involves many academic skills, such as reading, writing, and mathematics (Capraro et al., 2013). In addition, learning by making props products that are carried out collaboratively trains students' skills in communicating, critical thinking and active learning (Bell, 2010). In the group, students can practice asking

questions and discussing results with other friends that allow students to learn to solve problems and make decisions (Mehta & Kulshrestha, 2014).

3.4. Student responses to learning

Increasing students' creativity with the application of project-based learning models, also followed by a positive response to the implementation of the model. This can be seen from the results of the student reflection questionnaire which states the atmosphere of learning is fun and happy with this model by 100%, which is motivated by the application of this model by 97.3%, which considers learning more effective and can easily accept lessons by 94.6%. Students also feel, to complete the project in accordance with the problem being solved, students will strive with their creative thinking skills to complete their project tasks by utilizing the concepts they have received in classroom learning. This is what students feel makes them more aware of the concepts they are learning.

3.5. Constraints in the implementation of actions

This study certainly does not run smoothly, there are some obstacles or obstacles. These constraints include some students who still have low motivation to attend lessons because students assume that this learning is too difficult and adds daily tasks. In addition, some low-ability students still have difficulty in balancing other students in working teams or groups, so that students tend to have high abilities who always look superior. This can cause students with low abilities to feel insecure in presentations and practices.

Meanwhile, to deal with low-ability students is done by giving students the opportunity to answer questions when presenting and also provide opportunities to practice in front of the class and give awards if the practicum is done correctly, so students are motivated to learn and able to compete with capable students high. Therefore, a teacher must be creative in motivating and handling students who need special attention as conveyed by Sumarni (2015) that in the implementation of PjBL, creative teachers are needed. Teachers must be able to solve problems, especially to deal with students with low abilities, lack of motivation, and lack of focus, so as to improve teacher-student relations.

4. Conclusion

Based on the results of research and discussion, it can be concluded that the application of PjBL with the project task of making simple pyrolysis and distillation tools can improve creative thinking skills in chemistry learning in 3 cycles in terms of fluency, flexibility, originality, and elaboration. Until the end of the third cycle, it appears that the average of all indicators of creative thinking skills of students are in the creative predicate, with a high increase in each indicator of fluency and elaboration.

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