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JURNAL SYNTAX TRANSFORMATION

PROFILE OF CREATIVE THINKING SKILLS OF S1 CHEMISTRY STUDENTS ON THE TOPIC OF DNA ISOLATION USING PROJECT BASED LEARNING (PJBL)

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Abstract
This study aims to obtain information about creative thinking skills in students through the application of the *project based learning* (PjBL) model on the topic of DNA isolation. The research method used is *mixed-method embadded with* One Group Pretest-Posttest pre-experimental *research design*. A limited trial was conducted on 33 chemistry education study program students at one of the State Universities in Bandung. The instruments used in this study are structured description and MFI problems. Data analysis using *pretest and* posttest *values using the* N-Gain equation <g> *and* obtaining the percentage of MFI values per group. The results of the creative thinking assessment showed that the N-gain value obtained was 0.78 with a high category. Other results from this study obtained percentage values on each indicator of creative thinking skills including flexibility thinking skills (flexibility*) 87.88%, fluent thinking (*fluency) 93.94%, original thinking (originality) 85.95% thinking elaboration (*elaboration*) 87.88%, Thinking evaluation (*evaluation*) 93.94% with a very good category after students carry out learning with the PjBL model can improve students' creative thinking skills on the topic of fruit DNA isolation.
Keywords: DNA Isolation, Creative Thinking Skills, *Project Based Learning*

INTRODUCTION

Add your own sentence first that explains the facts that exist today. Entering the 21st century skills skills) red discard of the 21st century global changes must be able to be faced. To be able to face various demands in changing times, thinking skills are needed (Rahmi et al., 2017). Gilang Ahmad Nugroho (2017) said that creative thinking skills and innovation are one of the keys to facing competition. Creative thinking is a high-level skill needed by students in solving problems, both in terms of learning and in their daily lives (Mashami et al., 2020).

Creative thinking skills are referred to as the process of ability that describes fluency, flexibility, and originality in terms of thinking, as well as being able to elaborate in developing, detailing and enriching ideas (Andrle et al., 2009). Creativity can directly provide opportunities for students to conduct a scientific investigation of various phenomena experienced differently (Bereczki &; Kárpáti, 2018). Creative thinking in life can give you confidence and increased

achievement. Shows that red waste Creative thinking is very important and must be owned by every individual in order to solve problems in complex life in this era of red waste (Ernawati *et al*., 2019). Thus, kCreative thinking skills are important to develop in the learning process.

Given the need to be skilled in creative thinking, the Indonesian government has integrated creative thinking skills into part of the education curriculum. This has been formulated in Law No. 20 of 2003 article 3 concerning the National Education System with the aim of developing the potential of students to become human beings who believe and fear God Almighty, have noble character, healthy, knowledgeable, capable, creative, independent and become democratic and responsible citizens (Secretariat et al., 2003).

The importance of creative thinking skills is not accompanied by maximum results from these creative thinking skills. This is shown from the results of research conducted by Supriyanti (2021) regarding DNA extraction, stating that the ability to generate many ideas (*fluency) obtained an average of 42.15% N-gain, the ability to generate new ideas from the previous way (*originality*) obtained an average of 63.58% N-gain, the ability to improve or add ideas to produce more detailed ideas (elaboration*) obtained an average N-gain of 38.97%, while in the ability of students to look at a question or topic from a different perspective (*flexibility*) only obtained an average N-gain value of 15.86%. These results show that creative-based learning habituation needs to be done in the teaching and learning process on the topic of DNA isolation.

This low creative thinking skill is caused by lecturers who choose a *teacher-centered* approach, which makes students lack creativity and innovation (Syamsidah et al., 2020). In line with this, (Schueller et al., 2018) stated that low creative thinking skills can be caused by educators not being right in choosing the learning model used.

One learning model that can be used to improve creative thinking skills is *project based learning* (PjBL) (Fahmi et al., 2020). The PjBL model is a comprehensive learning model and can involve students in cooperative and continuous investigation activities (Candra, et al., 2019). The PjBL model can focus on a number of problems that can motivate, and encourage students to face the main concepts and principles of knowledge directly as first-hand experience or *hands-on experience* (Desnylasari et al., 2016) (Rushiana et al., 2023)

Previous research conducted by Noviyana (2017) stated that the influence of project-based learning models affects the creative thinking skills of students. Chemistry learning that involves developing creativity not only has a positive influence on students' chemistry image and competence, but also fosters students' motivation to become chemists (Astuti, 2015).

One of the lessons that can use the PjBL model is DNA isolation (Zubaidah, 2019). DNA isolation is the process of separating DNA components from within the cell (extraction or lysis). The DNA isolation process is carried out homogenization and the addition of *lysis buffers or extraction* buffers to prevent DNA damage (Yuwono, 2008). DNA isolation practicum, can use local materials such as pineapple as samples in DNA isolation.

Based on the application of the background above, the creative thinking skills of chemistry education students still need to be developed. For this reason, researchers apply the PjBL model to DNA isolation practicum from various types of pineapples to be able to develop students' creative thinking skills.

METHOD

This research uses a combined method between qualitative and quantitative (*mixed-method*) with an approach *embedded mixed-methode*. Research methods *embedded mixed-method* is a combination of qualitative and quantitative data collected by researchers simultaneously during the study (Creswell, 2014).

The quantitative approach used in this study is *Pre-experimental* by design *One Group Pretest-Posttest* (Fraenkel *et al*., 2011). This design does not use a control class as a comparison, researchers measure the increase in students' mastery of concepts through giving *Pretest* to the group that is given the treatment, then give *Treatment* namely the learning process and finally followed by giving *posttest*. The magnitude of influence *Treatment* can be known more accurately through a comparison between the results obtained from the initial test and the final test (Wiersma, 2000). Research design *Pre-experimental* in simple terms can be seen in Table 1.

Table 1. *One Group Pretest-Posttest Research Design*

Pretest	**Treatment**	***Posttest***
O1	X	O2

Information:

O1 = Pretest measures students' creative thinking skills and mastery of concepts

X = Treatment Group using *project based learning*

O2 = posttest to measure students' creative thinking skills and mastery of concepts.

Embedded analysis is carried out by comparing quantitative and qualitative data simultaneously and complementing each other. Quantitative data includes pretest and posttest scores of creative thinking skills. The qualitative data is in the form of answers from student MFIs in groups.

This research applies the PjBL learning model, the first meeting begins with giving pretests to students. After finishing the lecturer, distributing MFIs and conducting perceptions through essential questions about the role of DNA in the decline of genetic traits of a species, then the lecturer ordered to create a group of three people followed by compiling a schedule for the distribution of tasks and the person in charge of the project. The second meeting of students carried out a mini *DNA isolation reasearch* , during the implementation of the project students had the right to consult or ask lecturers or practicum assistants. Monitor students during the project and it is expected that students will be able to handle when they experience obstacles during the project work process and complete them properly. For the learning evaluation stage, students present the design of DNA isolation procedures and conclude the results of the pineapple fruit project in detail. At the third meeting, students were given a posttest, and after completion they would fill out a response questionnaire about the project-based learning model. The results of the Creative Thinking assessment or test are analyzed using N-Gain.

The sample in this study was taken by saturated sampling technique, which is a sampling technique when all members of the population are used as samples. The sample used in this study was even semester FPMIPA students at one of the State Universities in the city of Bandung totaling 33 people. The paragraphs should be relatively the same.

The instrument used to determine individual creative thinking skills against the project-based learning model by taking data quantitatively using creative questions consisting of 14 questions with creative thinking indicators according to William which include fluency, *flexibility*,

originality*, elaboration thinking indicators* and evaluation thinking. Then to find out the creative thinking skills of students in groups, qualitative data collection was carried out through MFI instruments. Knowing the percentage of creative thinking skills is carried out percentage descriptive statistical analysis, based on a predetermined index of criteria. How to see students' creative thinking skills in this study by providing 12 questions for each meeting with indicators William (Munandar, 2009) which include *fluency,* flexibility, *originality,* elaboration*,* and *evaluation*; by using different score assessments toap questions. Provision of MFIs to find out the results of students' creative thinking skills. The results of MFI work are calculated using descriptive analysis.

RESULTS AND DISCUSSION

Improving students' creative thinking skills

Table 1 shows a recapitulation of the pretest and posttest scores given to 33 students involved in the study. In the pretest the highest score obtained was 74.80 and the lowest score was 41.80, while in the posttest, the highest score was 96.80 and the lowest score was 85.80. The average pretest and posttest scores of students were 59.61 and 91.51, respectively.

Student pretest and posttest data are used in the calculation of N-gain. This N-gain test is used to determine the improvement of students' creative thinking skills after going through the learning process with the PjBL model. The N-gain value obtained is 0.78. According to Hake (1999), the N-gain value indicates an increase in creative thinking skills with a high category.

This is because the PjBl model emphasizes contextual learning and involves students in conducting investigations collaboratively (Kusadi et al., 2020). The results of this study are in line with research conducted by Fajrina *et al* (2018) showing that creative thinking skills are influenced by the PjBL model by 63%, In addition, Gultom (2022) obtained results that students' creative thinking skills have increased with a gain score of 0.77 with a high category.

Table 1. Recapitulation of *Pretest* and *Posttest Scores*

Parameters	Pretest	Posttest
N	33	33
Highest score	74,80	96,80
Lowest score	41,80	85,80
Average score	59,61	91,51
N-gain	0,78	

Improving Student Creative Thinking Skills for Every Indicator of Creative Thinking Skills

Learners' pretest and posttest data for each indicator of creative thinking skills can be seen in Table 2. The average pretest and posttest data are used to calculate the N-gain value as in the table; next.

Table 2. Pretest, posttest and N-gain recapitulation for each creative thinking indicator

Creative Thinking Indicator	Pretest	Posttest	N-gain (Category)

Fluency	7,81	8,88	0.89 (High)
Flexibility	6,94	8,75	0.88 (High)
Originality	5,13	9,97	0.82 (High)
Elaboration	4,09	7,84	0.96 (High)
Evaluation	3,06	5,91	0.97 (High)

Table 2 shows that the *fluency* indicator obtained an average N-gain score of 0.89 in the high category. The *fluency* indicator includes creative thinking skills instruments on questions number 1, 2 and 3. The indicator of flexible thinking (*flexibility*) is measured by questions number 4, 5 and 6. This indicator obtained an average N-gain score of 0.88 in the high category. The original thinking indicator was measured using questions with numbers 7, 8 and 9 This indicator obtained an average N-gain score of 0.82 in the high category. The elaboration thinking indicator is measured using questions with numbers 10 and 11 This indicator obtained an average N-gain score of 0.96 in the high category. The evaluation thinking indicator is measured using questions with numbers 12, 13 and 14 This indicator obtained an average N-gain score of 0.97 in the high category.

Improving students' creative thinking skills on each individual creative indicator occurs because students are required to be able to analyze a problem in providing creative ideas and ideas and provide alternatives if there are things or problems in the implementation of practicum doing DNA isolation. Based on the efforts produced by individual students, it is stated that students' creative thinking through project-based learning has increased in creative thinking

The results of DNA isolation experiments with the results of filling MFIs in which there is a design of research procedures in accordance with the syntax of project-based learning, have been carried out by students in groups stating that the project-based learning model has a positive impact on students, as evidenced by the high value of MFIs and percentages. One study that developed worksheets as conducted by Mihardi, et al (2013), about the effect of the project PjBL model with worksheets on the creative thinking process of learners.

MFIs can also be packaged by explaining problems related to the application of material concepts in everyday life whose resolution can be done through project tasks. MFIs serve as a guide for students in learning and discovering concepts through the activities carried out. This is in line with the statement of Guruh et al (2018) that the use of MFIs can make student learning activities more focused. MFIs that are designed attractively and systematically can help students learn more actively both independently and in groups.

In line with the research that has been done, Student Worksheets can provoke students to be involved in the learning process (Nugraheni et al., 2018). Through learning with project-based MFIs, students become more interested in actively participating in learning so that their interest will increase and understand the material more deeply and thinking skills.

Score acquisition data for each indicator of creative thinking skills through MFIs can be seen in Table 3.

Table 3. Recapitulation of the Percentage Group of Each Creative Thinking Indicator

Creative Indicators	Question Number	Aspects of Creativity Assessment	Percentage (%)
Flexibility	Heading	Mention the title with the right method	87,08 %
	Purpose	Mention the purpose of the Fruit DNA isolation practicum	
	1	Determine the local material of pineapple fruit types that can be used as DNA isolation practicum material.	
	2	Determine the formulation of the problem to be studied	
	5	Determining dependent variables, independent variables and control variables in pineapple fruit isolation research	
	6	Determining how to isolate DNA from pineapple fruit	
	7	Mention the environmentally friendly lysis buffer to be selected for pineapple fruit DNA isolation experiments	
Fluency	3	Explaining how to get DNA from pineapple fruit is related to the need to use chemicals?	94,55 %
	9c	Explain the purpose of each stage carried out	
	10	Record observational data of pineapple DNA isolation experiments	
Originality	8	Design practicum procedures that will be used in DNA isolation experiments on pineapples	85,95 %
	9a	Identify tools and materials used in DNA isolation experiments on pineapples	
	9b	Mention the stages of obtaining DNA from pineapple fruit sources	
Elaboration	4	Explain the basis for choosing DNA sources from pineapple fruit	87,88 %
	11	Compare trial data to ensure detergents are proven to be more effective and provide the right reasons	
Evaluation	12	Conclude the results of the pineapple DNA isolation practicum activities that you have done. Then analysis are there other	93,94 %

Creative Indicators	Question Number	Aspects of Creativity Assessment	Percentage (%)
		variables that can be examined in studying the DNA content in vegetables and fruits?	

Table 3 shows that *the flexibility* indicator obtained a percentage of 87.88% in the very high category. This thinking indicator includes creative thinking skills instruments in the title, goals, numbers 1, 2, 5, 6, 7 and 3. The fluency indicator is measured by questions number 3, 9c and 10. This indicator obtained a percentage of 93.94% with a very high category. Indicators of originality are measured using questions with numbers 8, 9a and 9b. This indicator obtained a percentage of 85.95% with a very high category. Elaboration thinking indicators are measured using questions with numbers 4 and 11. This indicator obtained a percentage of 87.88% with a very high category. The evaluation (evaluative) thinking indicator is measured using the question with the number 12. This indicator obtained a percentage of 93.94% with a very high category.

The improvement of students' creative thinking skills on each indicator occurs because students are required to be able to analyze a problem in DNA isolation. Students must also be able to explain various efforts in finding alternative local materials that can be used for DNA isolation practicum and design practicum procedures with appropriate methods. Based on the efforts produced by students in groups, it was stated that students' creative thinking through PjBL has increased in creative thinking.

CONCLUSION

Based on the results of the study results obtained N-gain values on five indicators which include *flexibility* thinking, fluency, originality, *elaborative* thinking and evaluation thinking, the N-gain value of 0.78, shown to show categories high. Other results obtained the percentage of group values which include flexible thinking (flexibility) obtained a percentage of 93.94*%, fluent thinking (*fluency) obtained a percentage of 85.95%, original *thinking (*originality) obtained *a percentage of* 87.88%, obtained the percentage of elaborative thinking *(elaboration)* 87.88% and evaluation thinking (*Evaluation)* obtained a percentage of 93.94%. With this percentage, it shows that the student group is in the "very high" category. It can be concluded that the application of the PJBL model can improve the creative thinking skills of even-semester students in biochemistry courses on the topic of DNA isolation.

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