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## **Manuscript Writing Guidelines: Analysis of Creative thinking skills profile of Senior High school students in Madiun City on Biotechnology topic**

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### **ABSTRACT**

#### **KEYWORDS:**

*Creative thinking skill  
Biotechnology  
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Biology  
Senior High School*

Currently, the world of education has returned to normal after the outbreak of Covid-19. The newest curriculum implemented in Indonesia is the independent curriculum. One of the important competencies trained in the independence curriculum is creative thinking skills. Creative thinking skills are important for long-term success because they help see problems and situations from different perspectives to solve problems. The purpose of this study was to analyze the profile of students' creative thinking skills in biotechnology material. This research is a descriptive research with a written test method that includes creative thinking skills. The subjects of this study were 35 students of SMAN 6 Madiun who were selected using a purposive sampling technique. The results obtained show that the percentage of achievement of creative thinking skills as measured using 4 aspects of adaptive creative thinking skills according to Torrance and Guildford namely fluency 60%, flexibility 44,64%, originality 40,36%, and elaboration 57,85%.

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## **1. INTRODUCTION**

Seeing the current conditions, education around the world including Indonesia has gradually recovered from the effects of the covid 19 pandemic which is implementing social distancing as a policy to prevent the spread of covid-19 (Hamid 2020). This policy has changed all aspects of life, one of which is in the field of education. In order for learning to continue, the Indonesian government has implemented online learning. But now the pandemic is over so it is no longer implementing distance learning.

The era of the industrial revolution 4.0 in the 21st century demands developments in all sectors of life, including education and learning. The progress of human life is influenced by technological developments, including in the field of education. Changes in information systems that develop and human resources that have been replaced by technology affect the education system. Most high schools in Indonesia have implemented the latest curriculum, namely the independent curriculum. Unlike other programs, the Merdeka Curriculum has a distinctive feature which is defined as an emphasis on the use of teaching methods that focus on students and reduce pressure by using a teaching model based on Project based learning (PjBL) (Pratiwi 2019) is part of the independent curriculum which presents interesting and innovative teaching.

To face the demands of the 21st century in implementing independent curriculum, the prioritized skills in learning known as 4C according to are; critical thinking and problem solving, communication and collaboration, as well as creativity and innovation (Bernie Trilling & Charles Fadel 2009). Characteristics of the 21st century to solve life's increasingly complex problems requires effective and efficient solutions (Saputri et al. 2018). One of them is creative thinking skills, in fact, according to the results of the Global Creativity Index, Indonesia is ranked under

the creative and innovative index (Florida et al. 2015). Looking at these results, it is necessary to emphasize that creative thinking skills must be improved so that students are ready to face the era of the industrial revolution 4.0 even though in this post-pandemic period. Creative thinking skills are the ability of individuals to find new ideas, new possibilities, new discoveries that use their minds based on originality in their work (Daud et al. 2012). Creative thinking is an activity that generates new ideas, allows something to be seen from a different perspective, is imaginative, has the potential to produce advanced ideas and changes, is capable of generating many ideas and is skilled at solving problems (Ülger 2016). According to Torrance and Guilford there are 4 aspects of creative thinking, namely; 1) fluency is the skill to create many ideas, 2) flexibility is the skill to propose several approaches or ways to solve a problem, 3) originality is the skill to create authentic ideas as a result of their own thinking and not cliches, 4) elaboration is the skill to describe something in detail. Therefore, this study uses an open test with 4 aspects of creative thinking such as fluency, flexibility, originality, and elaboration (Guilford, 1987). This research aims to identify and describe the creative thinking skills of SMAN 6 Madiun students in learning Biology on biotechnology material.

## 2. MATERIALS AND METHODS

This research is a qualitative descriptive study. Measurement of students' creative thinking skills using description questions with each indicator was developed based on 4 aspects of creative thinking skills adapted from Torrance and Guilford, these four aspects are fluency, flexibility, originality, and elaboration. The questions tested consisted of eight questions, while each aspect of creative thinking skills was represented by two questions. The subjects in this study were 35 students of SMAN 6 Madiun who were selected through a purposive sampling technique. Where the students who were given the test were students who had taken Biotechnology material. The development of a question instrument using aspects of creative thinking skills adapted from Torrance and Guilford in (Anjarwati et al., 2018) can be seen in table 1

**Table 1.** Creative Thinking Skills Profile Test Instrument.

Number of question	Creative thinking skill's aspect	Creative thinking skill's indicator
1,2	Fluency	a. Mention many ideas that are relevant to the problem b. Flow of thought smoothly
3,4	Flexibility	a. Provide an interpretation of a picture or a phenomenon b. The skills to view things from different perspectives c. solve a problem from various points of view
5,6	Originality	a. Generating answers from one's own thoughts that are relevant and different from answers in general b. Generating new ideas on a problem c. Creates unusual or rare answers that no one else has thought
7,8	Elaboration	a. Developed or enrich existing ideas b. Extend answers and link between concepts

Number of question	Creative thinking skill's aspect	Creative thinking skill's indicator
		c. Analyze and finding various approaches to solving a problem
		d. Determining an opinion about a thing

The data were obtained from students' answers by coding each student's answers and students' answers based on table rubrics. The percentage scores obtained by students in each creative thinking skills aspects are then converted into proportions using the formula:

$$\text{Percentage Score} = \frac{\text{obtained score}}{\text{maximum score}} \times 100$$

The result of the percentage score of each aspect is indicated by the criteria according to this article (Riduwan 2010). These categories are shown in table 2 The Percentage Category of Creative Thinking Skills.

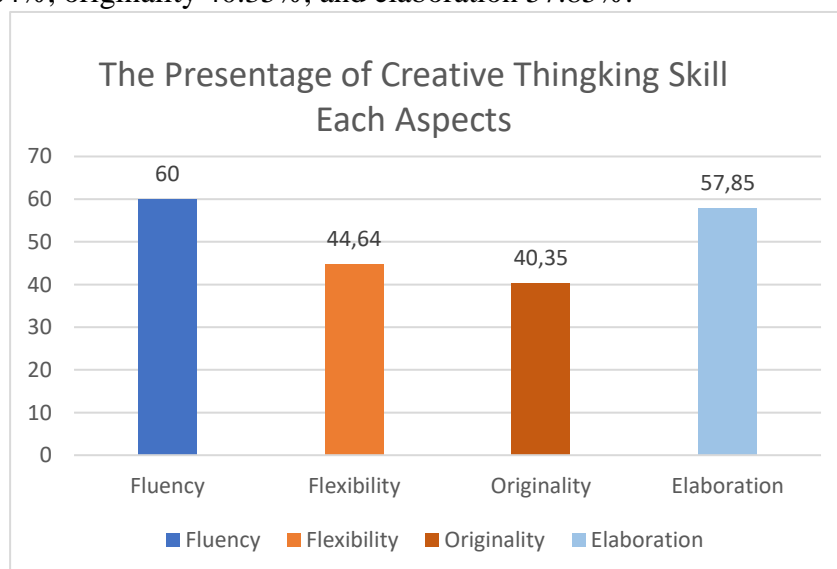
**Table 2.** The Percentage Category of Creative Thinking Skills

Percentage	Category
81 – 100 %	Very creative
61 – 80 %	Creative
41 – 60 %	Moderate
21 – 40 %	Low
0 – 20 %	Very low

The results of the analysis of students' creative thinking skills are displayed in graphic form and analyzed descriptively.

### 3. RESULTS AND DISCUSSION

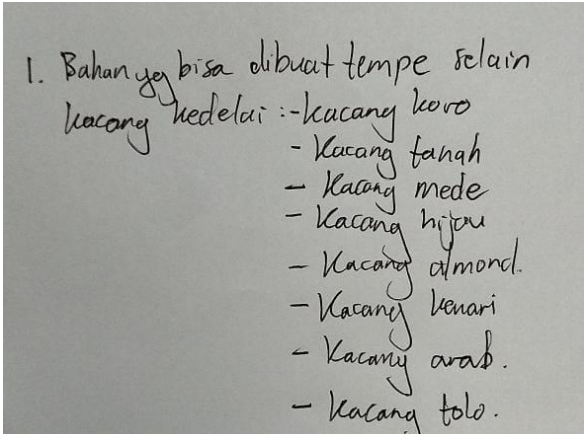
The results of students' creative thinking skills tests can be shown in Figure 1. This figure shows the highest results on the aspect of fluency as much as 60% which fall into the medium category. Meanwhile, the other three aspects are included in the low category with the following details; flexibility 44.64%, originality 40.35%, and elaboration 57.85%.



**Figure 1.** The Presentage of creative thinking skill each aspects

The four aspects of creative thinking skills, the Fluency aspect has the highest percentage and is included in the medium category with a percentage of 60%. Fluency can be seen from students who give correct, fluent, and varied answers (Nurdiana et al.2020). This shows that students are able to name many answers to the questions that have been given. There are more than half of the sample population can answer questions on this aspect. One way that can be done by the teacher to develop fluency is to frequently ask questions to students, so that students are accustomed to giving many answers (Munandar, 2009). The following are examples of questions and answers from students on the fluency aspect which can be seen in table 3 below.

**Table 3.** The examples of questions and answers from students on the fluency aspect



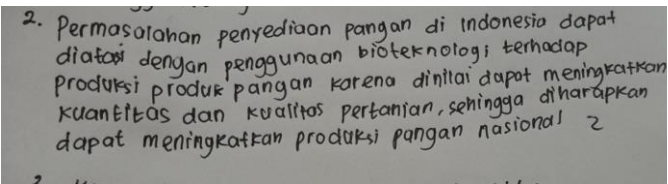
Original Question and Student answer	In English
<p>Tempe merupakan produk bioteknologi yang dihasilkan dari fermentasi biji kedelai atau beberapa bahan pangan lainnya. Fermentasi menggunakan beberapa jenis kapang <i>Rhizopus</i>, seperti <i>Rhizopus oryzae</i>, dan beberapa jenis kapang <i>Rhizopus</i> lainnya.. Tempe merupakan makanan yang kaya akan serat pangan, seperti protein, kalsium, vitamin B dan zat besi. Coba kalian berikan contoh bahan pangan lain yang dapat diolah menjadi inovasi tempe selain kedelai sebanyak-banyaknya !</p>	<p>Tempe is a biotechnology product, its produced from fermented soybean seeds or some other food ingredients. Fermentation uses several types of <i>Rhizopus</i> mold, such as <i>Rhizopus oryzae</i>, and several other types of <i>Rhizopus</i> mold. Tempe is a food that is rich in dietary fiber, such as protein, calcium, B vitamins and iron. Try to give as many examples of other food ingredients that can be processed into tempeh innovations besides soybeans!</p>
<p>Students Answer :</p>	<p>Students Answer :</p>
 <p>1. Bahan yg bisa dibuat tempe selain kacang kedelai :- kacang koro  - kacang tanah  - kacang mede  - kacang hijau  - kacang almond.  - kacang kenari  - kacang arab.  - kacang tolo.</p>	<p>The ingredients that can be made into tempe besides soybeans are :  “Koro” bean  Peanut  Cashew  Almond  Walnut  Chickspeas  Little red bean</p>

Based on the student answers in table 2 above, it is good enough to provide answers in a fluent and varied manner, but there are still some students who have not been able to answer the questions with a perfect score. This happens because students more often use answers they remember from examples in textbooks so that they have not maximized the results of other thoughts to mention examples of correct answers but not as common as those already in the book. To provide examples of various answers to a problem, students can think broadly according to their understanding and abilities. The ability to think creatively can be obtained from everyday life experiences, apart from textbooks, namely sourced from information found on television or newspapers, as well as other learning sources so that students can respond smoothly to a question, in line with (Hennessey & Amabile 2009) is identifying, defining, and solving problems are important aspects of creative thinking

Flexibility is a skill that involves openness to create an idea in solving a problem from various perspective (Alrubaie & Daniel 2014). The flexibility aspect is the second lowest percentage after the originality aspect, which is 44.64% and is included in the low category. These results can be seen from the answers of students who are still not fully able to answer the questions given, besides

that students are also not able to produce new ideas that arise from other perspectives related to the problems presented in the questions. Students should be aware of how to generate new thoughts to solve problems but students only focus on convergent thinking processes because they are limited to verbal reasoning and logical thinking, so students are accustomed to convergent thinking, and if a problem is given, they will have difficulty solving the problem. creatively (Amalia et al. 2020). The following is an example of questions and answers from students on the flexibility aspect which can be seen in table 4 below.

**Table 4.** The examples of questions and answers from students on the flxibility aspect

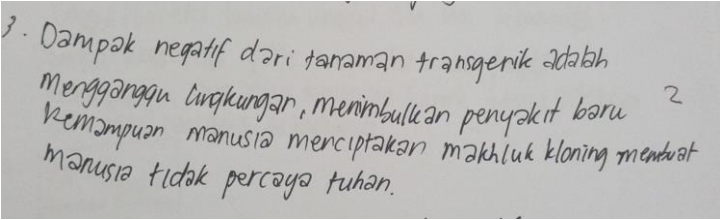
Original question and student answer	In English
<p>Question :</p> <p>Scan Barcode dibawah ini menggunakan smartphone kalian kemudian baca artikel tersebut dengan teliti !</p>	<p>Question:</p> <p>Scan the barcode below using your smartphone then read the article carefully!</p>
	
<p>Link : <a href="http://bit.ly/3MVOsfX">http://bit.ly/3MVOsfX</a></p> <p>Setelah membaca artikel diatas, analisislah dan berikan tanggapan kalian tentang perananan bioteknologi terhadap produksi produk pangan!</p>	<p>Link : <a href="http://bit.ly/3MVOsfX">http://bit.ly/3MVOsfX</a></p> <p>After reading the article above, analyze and give your feedback about the role of biotechnology in the production of food products!</p>
<p>Student answer :</p> 	<p>Student answer :</p> <p>The problem of food supply in Indonesia can be overcome by using biotechnology for the production of food products, because it is considered to be able to improve the quality and quantity of agriculture, so that it is expected to increase national food production.</p>

Based on student responses in table 4, students are able to answer questions but student answers are still not perfect in conveying new ideas or ideas in viewing and solving a problem. Supposedly, students are able to provide different interpretations of the questions presented, then students can classify various answers or write down ideas from the problems posed in these questions (Anderson, LW 2001). At the stage of creative thinking is part of the cognitive skills to propose a solution to a problem or make something useful and new than usual, as well as problem solving activities, can develop general cognitive skills that can be used to develop creative thinking skills (Trisnayanti et al. 2020).

After seeing the various student answers, the teacher realized that the students had not produced a new thought to solve the problem but the students only focused on convergent thinking processes because they were limited to verbal reasoning and logical thinking, so students were used to convergent thinking, and if a problem was given, they will have difficulty solving problems creatively (Amalia et al. 2020). One of the teacher's efforts to improve students' creative thinking skills in the aspect of flexibility, teachers can train students to use open or divergent questions. The combination of two thinking skills including convergent and divergent thinking skills can help students to develop creative thinking skills (Sumarmo et al. 2012).

The originality aspect obtained the lowest percentage score from other aspects, namely 40.36%. Originality is the ability of students to provide answers or opinions on a problem that is unusual or different from others where answers are rarely given by most people and the answers are original from the thoughts of each student. The answers contain ideas or ideas that are unique and different from those that exist. in books and other people's opinions. This aspect relates to aspects of fluency and flexibility where fluency and flexibility in students' thinking influences students' originality thinking, so if fluency and flexibility are maximally developed in learning activities, students' originality abilities will definitely also be visible (Fauziah et al. 2017). The following is an example of questions and answers from students on the originality aspect which can be seen in table 5 below.

**Table 5.** The example of question and answer from students on the originality aspect


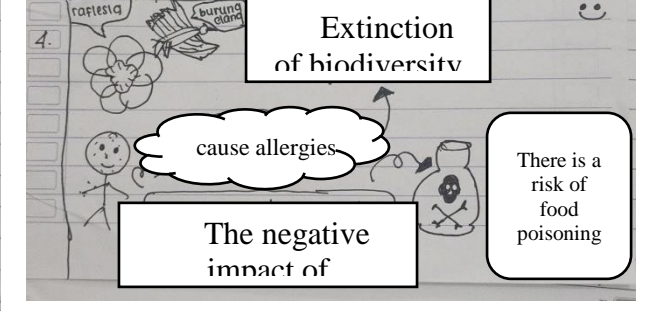
Original question and student answer	In English
<p>Questions:</p> <p>Jelaskan menurut pendapat kalian bagaimana dampak negatif dari produk bioteknologi modern terhadap lingkungan !</p> <p>Students Answer :</p>	<p>Question :</p> <p>Explain in your opinion how the negative impact of modern biotechnology on the environment!</p> <p>Students Answer :</p> <p>The negative impact of transgenic plants is that they disturb the environment and cause new diseases.</p> <p>Human ability to create living things through cloning makes people do not believe in God</p>
	

Based on the examples of student answers in table 5 above, it can be seen that student answers tend to have the same thoughts as their friends, and are still unable to provide more innovative and different solutions. This is in line with research conducted by other researchers on the same aspect, that aspects originality gets the lowest results from other aspects of creative thinking skills, because students still tend not to be able to, it is possible that students are still not able to create something original or original in accordance with the specified criteria. shows the wider the know-how, the more likely it is to bring up new ideas, so that they can influence one's original thinking abilities. (Trisnayanti et al. 2020).

The last aspect is Elaboration which gets a percentage score of 40.97%. In this aspect, the elaboration aspect occupies the second largest percentage score under the fluency aspect, even though the results are still in the low category. The elaboration aspect or detailed thinking is the student's ability to detail and find various approaches to problem solving (Munandar 2014). There are various efforts to develop creative thinking skills, teachers must cultivate curiosity in students, provide challenges to students, foster confidence that problems can be solved, and teach the ability that problems can definitely be solved. The following is an example of questions and answers from students on the flexibility aspect which can be seen in table 6 below.



**Table 6.** The examples of questions and answers from students on the elaboration aspect

Original Question and student answer	In English
<p>Question:</p>	<p>Question :</p>
<p>Buatlah rancangan poster tentang dampak negatif penerapan bioteknologi !</p>	<p>Make a poster design about the negative impact of applying biotechnology!</p>
<p>Student answer:</p>	<p>Student answer:</p>
	

Based on the examples of student answers in table 5 above, it can be seen that student answers are correct but still not detailed in making something more detailed and interesting. Effective training to enhance students' creative thinking usually focuses on strategies related to problem definition, conceptual combination, idea generation, and implementation planning (Walasari et al. 2019)

In general, the results of the average percentage of students' creative thinking skills in class X in biotechnology are still relatively low. This is because students are not used to facing questions that require them to think creatively. Students have not been trained to work on high-level thinking questions in accordance with the demands of 21st century skills and the demands of implementing an independent curriculum in which students are always given problems in each learning process that require students to think creatively. In addition, it also has to change learning that is used to using low-level thinking skills into learning that emphasizes higher-order thinking skills, one of which is creative thinking skills (Miri et al. 2007). Creative thinking skills are needed in online learning because students are required to learn independently and be able to find solutions to problems with new ideas. In the independent curriculum, creative thinking skills can be empowered through learning using models and PBL (Problem Based Learning) and PjBL, because each syntax of the learning model is able to direct students to apply higher-order thinking skills, one of which is creative thinking skills (Rahmawati 2023)

#### 4. CONCLUSIONS

The results of data analysis and discussion can be concluded that the creative thinking skills of class X students in biotechnology material are still low. Judging from the four aspects of creative thinking skills, only the fluency aspect is in the moderate category and the other three aspects are in the low category. Therefore various efforts are needed to improve students' creative thinking skills in every aspect, especially in the aspects of flexibility, originality, and elaboration, because these three aspects are in the low category.

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