



Critical and Creative Thinking Skills of Pekanbaru High School Students in Biology Learning

Tengku Idris*¹

¹Biology Education Study Program FKIP, Islamic University Riau, Indonesia

Received: June 9, 2022

Revised: November 12, 2022

Accepted: November 28, 2022

Published: November 30, 2022

Corresponding Author:

Tengku Idris

idrisbio@edu.uir.ac.id

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DOI: [10.29303/jppipa.v8i5.1737](https://doi.org/10.29303/jppipa.v8i5.1737)

Abstract: Critical and creative thinking are skills that are needed in this 21st century. These two skills are a priority for learning outcomes from various levels of education. This research is a survey that aims to see or measure the critical and creative thinking skills of high school students in Pekanbaru in online learning. This research sample consisted of 216 students who obtained 50% of the population of class XI IPA students at two public high schools in Pekanbaru City. The research instrument is in the form of critical and creative thinking questions that have been validated constructively by experts and empirically with a reliability value of. Based on the results of the study, it shows that the critical thinking skill of students of public senior high school class XI IPA in Pekanbaru is in the sufficient category with a percentage of 68.71% with the highest percentage being in the advance clarification indicator with a very good category while the other indicators are in the sufficient category. In creative thinking, the average skill of students in public senior high school class XI IPA in Pekanbaru is also in the sufficient category with a percentage of 64.43% with all indicators in the sufficient category. Based on the results of the study, it can be concluded that the ability of students in public senior high school class XI IPA at SMAN Pekanbaru is in a fairly good category.

Keyword: Critical Thinking Skills; Creative Thinking Skills; Biology Learning

Introduction

Education held in every educational unit, from basic education to higher education, should be the basis for the personal formation of students and society in general. However, in reality the quality of education, especially the output of education is still low when compared to the quality or output of education in other countries, both in Asia and in the ASEAN region. The challenge in the 21st century is how students are able to master the 4Cs which are considered important competencies, namely Critical Thinking, Creative thinking, Collaboration and communication (Duran & Sendag, 2012) (ITEEA, 2020). So it is very important to be taught at all levels of education (Udi & Cheng, 2015; Kezer & Turker, 2012).

Critical thinking and creative thinking are one of the cognitive domains that are currently very interesting to research (Ramón & López, 2021; Redifer et al., 2021; Snyder & Snyder, 2008). Some definitions of critical

thinking according to experts are as follows: According to Ennis (1992) critical thinking aims to achieve a reasonable and reflective assessment of what to believe, accept or do. In addition, other experts state that critical thinking is an intellectual discipline process that involves an ethical position that reflects consistency in thinking and acting (Davies & Barnett, 2015).

Critical thinking is very important for student success both in academics, life and work. Some important points why critical thinking is one of the goals in education are: (1) Critical thinking can develop if in the learning process it is often trained "from learning to thinking" (Perkins & Murphy, 2006); (2) The ability to think significantly increased at the high school level (Abrami et al., 2008); (3) Critical thinking is one of the skills that companies are looking for (Moore, 2013); (4) Critical thinking is high thinking and is one of the important things in making decisions (Diella & Ardiansyah, 2017).

How to Cite:

Tengku, I. (2022). Critical and Creative Thinking Skills of Pekanbaru High School Students in Biology Learning. *Jurnal Penelitian Pendidikan IPA*, 8(5), 2430–2436. <https://doi.org/10.29303/jppipa.v8i5.1737>

According to (Setyaningrum & Husamah, 2013) critical thinking is a systematic, directed and clear thought process which is a mental activity such as the process of observing, analyzing, researching, observing and others as a way of finding a solution in solving a problem. Critical thinking skills require practice and teaching because they are not inherited from parents or produced naturally (Nieto & Saiz, 2011). There is no detailed literature showing that a particular learning model or strategy is able to improve students' critical thinking. All factors in learning such as teachers, students, environment and learning models have interrelated effects (Rensburg & Rauscher, 2021). Meanwhile, according to (Kim et al., 2013) Critical thinking skills can be developed by learning complex, immeasurable problems, looking for alternative answers from different perspectives, or by connecting concepts with problems in everyday life.

In contrast to critical thinking, creative thinking is a mental activity carried out as a way to generate new thoughts and new understandings of a problem. Creative thinking involves a divergent phase in which different ideas are generated and a convergent phase involves the synthesis and evaluation of ideas (Qiang et al., 2020). In addition, creative thinking can be defined as a whole series of cognitive activities used by a person according to objects, problems and conditions as well as certain efforts towards an event according to his abilities. They use imagination, intelligence, insight and ideas when facing a problem (Soyadi, 2015). Creative thinking can also be defined as a person's cognitive process to generate ideas that are effective in solving problems under certain goals and conditions (Young & Balli, 2014; Kadir et al., 2017; Young & Balli, 2014). Creative thinking skills include imagination, independence, experimentation, etc. which are important aspects in the science learning process (Lince, 2016). While the creative thinking aspects that are most often used consist of originality, elaboration, fluency and flexibility (Handayani et al., 2021).

A person will find it difficult to think creatively without having critical thinking skills (Zhang et al., 2020; Pacheco & Herrera, 2021). This is in line with the findings of research conducted by (Tsai, 2019) and (Huerta et al., 2022) showing that critical and creative thinking have a strong and positive relationship with students in China and Spain. In addition, other studies have shown the same thing in business, nursing, health and education students (Akpur, 2020). Both critical and creative thinking skills can be trained with various learning models (Saputri et al., 2019; Sari et al., 2018; Wang et al., 2015 and Malik et al., 2020) certain media (Hastuti et al., 2018; Weatherspoon et al., 2015) or you can use a laboratory or experiment (Lisdiani et al., 2019; Setiawan et al., 2018).

Method

This research is descriptive research with research instruments in the form of critical thinking questions according to Ennis (2011) and creative thinking according to Guilfor, 1950, which have been validated constructively by assessment experts and learning experts and empirically.

The population in this study were all students of public senior high school class XI IPA Pekanbaru while the research sample consisted of 216 students from two public senior high schools in Pekanbaru with accreditation A. This research sample consisted of 216 students who obtained 50% of the population of class XI IPA students at two public high schools in Pekanbaru City. The data was processed by the percentage formula and categorized based on. The data is calculated by the formula (Spuck et al., 1975).

$$P = \frac{F}{N} \times 100 \tag{1}$$

Note:

P : Percentage

F: Frequency

N: number of samples

After that it is categorized based on the criteria (Asrul et al., 2014) as shown in Table 1.

Table 1. Categorization of Students' Critical and Creative Thinking Skills

Achievement	Category
86 - 100%	Very Good
76 - 85%	Good
60 - 75%	Fairly Good
55 - 59%	Poor
≤ 54%	Very Poor

Result and Discussion

Critical Thinking

Critical thinking skills are skills that must be possessed by today's young generation, these skills exit in all developing frameworks such as 21th Century, NGSS, ESD and it is even contained in Law no 3 of 2003 concering the goal Indonesian National education. It means critical thinking skills are the foundation for success in life future.

Based on the Table 2, it can be seen that the critical thinking skills of class XI science students at public senior high school Pekanbaru are in the fairly good category with a percentage of 64.43%. Of the 5 critical thinking indicators used, the highest percentage is found in the inference indicator with a percentage of 73.85 in the fairly good category, while the inference indicators, elementary clarification (67.15) while the indicators with the lowest category are basic support indicators (55.80%)

and strategy and tactic indicators (57.85%) with the poor category.

Table 2. Critical Thinking Skill of Pekanbaru Public Senior High School Students

Indicator	Percentage		Average
	School X	School Y	
Elementary clarification	62.00	72.30	67.15
Basic support	39.80	71.80	55.80
Inference	76.90	70.80	73.85
Advance clarification	93.10	84.70	67.50
Strategy and tactics	40.70	75.00	57.85
Average	63.00	75.00	64.43

Table 2 shows that of the five critical thinking indicators (Ennis, 2011), it shows that the highest ability is in inference ability with a percentage of 73.85 with a fairly good category. Critical thinking skills on inference indicators include the ability to make deductions and consider the results of deductions or make inductions and consider the results of induction then make decisions and consider the results. Inference according to (Davis, 2015) is the ability to identify and select the elements needed to draw conclusions that choose reasons, to establish a diagnosis, to consider what information is needed and to decide the consequences that must be taken from data, information, statements, events, principles, opinions, concepts and so on. Then the conclusion according to (Elisanti et al., 2018) is the skill to identify and select the elements needed to form reasonable conclusions or to form hypotheses regarding relevant information and to reduce the consequences of data, questions, principles, evidence, judgments, belief, opinion, concept, description, question or other form of representation.

The elementary and advance clarification indicators are in the same category, namely in the fairly good category with a percentage of 67.15% for elementary clarification and 67.50% for advanced elementary clarification. On the ability to think critically on the indicators of building skills.

Basic includes the ability to evaluate the credibility of sources and observation reports. While in advance clarification students must be able to review and thoroughly examine the decisions taken. Students must be able to define a term and consider definitions and be able to identify assumptions or statements that are considered true so that appropriate conclusions can be drawn. To be able to do advance clarification, students must be able to do basic clarification.

Indicators of basic support and strategy tactics get the lowest score below 60% on students' critical thinking skills. On indicators of managing strategies and tactics students must be able to decide on a strategy or look for other unusual alternatives in solving a problem. The

ability on this indicator is still weak because students are accustomed to using common solutions and rarely get the opportunity to solve problems based on their abilities but usually follow the solutions given by the teacher or parents.

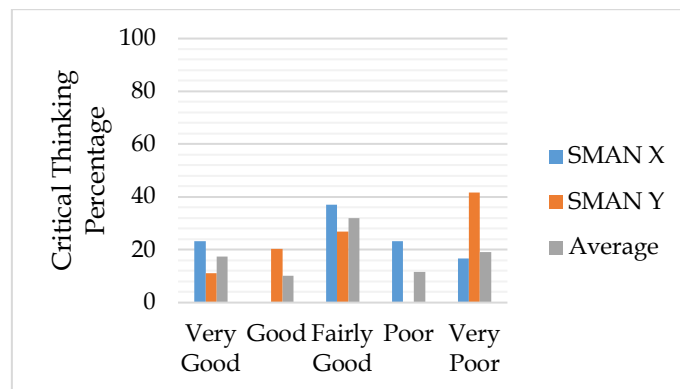


Figure 1. Percentage Critical Thinking Category

Figure 1 shows that the critical thinking skill of Pekanbaru public senior high school students in learning biology is mostly in the sufficient category with a percentage of 31.9% or 69 people while the number of students in the good category is 27.30% and as many as 30.7% students are in the poor category.

Critical thinking is one of the skills needed to face the demands of the 21st century in all aspects of life, both in the fields of work, education, social culture and economy (Swart, 2017; Snyder & Snyder, 2008). Critical thinking skills help students evaluate possibilities and make decisions and present reasonable solutions to uncover and solve complex problems (Facione, 2011; Haghparast et al., 2019; Yu et al., 2020).

In line with the data above, Figure 1 also shows that the majority of students have critical thinking skills in the sufficient category and 30.7% of students in the poor category. The low ability of students to think critically should be an alarm for teachers and all stakeholders involved, because critical thinking is one of the skills that are needed to survive in global competition and the 21st century. Based on research showing that critical thinking skills can trained and improved with various approaches or models, strategies, media, learning resource and lab activity. (Rauscher & Badenhorst, 2021). There are several models that can be used by teacher to train critical thinking that is in line with the characteristics of biology learning such as inquiry (Duran & Sendag, 2012) problem based learning (Ekosari, 2018; Yulianti & Gunawan, 2019), Project Based learning (Insyasiska et al., 2015) and discovery learning (Chusni et al., 2022).

Creative Thinking

In addition to critical thinking, creative thinking is a skills needed by society in the industrial revolution 4.0

and 21st century skills. According to (Torrance, E., & Goff, 1990) creative thinking is recognizing missing gaps and the ability to generate fluency, flexibility, originality and elaboration. In addition creative thinking means generating news ideas that are different form previous ideas which the idea produces something better (Palanica et al., 2019).

Table 3 shows that the creative thinking skill of public senior high school students in Pekanbaru is in the sufficient category with a percentage of 67.80%. The highest category is the fluency indicator with a percentage of 80.45% in the good category, while the elaboration, flexibility and originality indicators are in the fairly good category.

Table 3. Creative Thinking Skill of Pekanbaru Public Senior High School Students

Indicator	Percentage		Average
	SMAN X	SMAN Y	
Fluency	85.4	75.5	80.45
Ellaboration	51.4	70.8	61.10
Flexibility	69.4	62.5	65.95
Originality	50.2	77.1	63.65
Average	64.1	71.5	67.80

Figure 2 shows that the creative thinking skills of public senior high school class XI IPA students in online biology learning are in the good and very good categories with a percentage of 54.60%, and only 16.6% in the sufficient category, the rest in the poor category (28.7%).

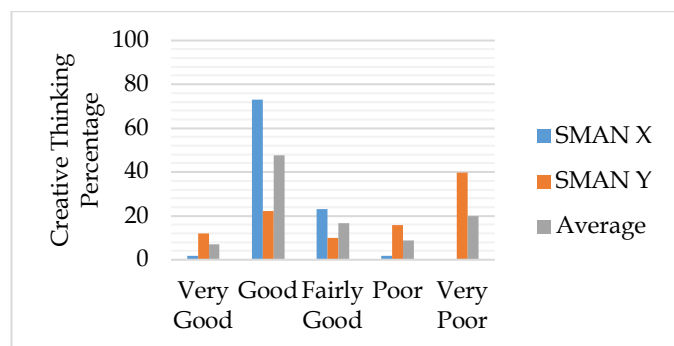


Figure 2. Percentage Creative Thinking Category

Based on Table 3 and Figure 2 shows that the creative thinking skill of Pekanbaru public senior high school students is in a fairly good category with a percentage of 67.80%. in line with that the number of students who have very good and good creative thinking is more than 50%, however, there are still students in the less and less category (28.7%). Creative thinking is developing thoughts from information into various ideas or points of view. Individuals who are able to think creatively will be able to produce new concepts, ideas, or products that are different from the existing concept, idea, or product (Sani et al., 2019). According

to (Setyaningrum & Husamah, 2013) creative thinking is a mental activity that solves problems, proposes methods, ideas or provides new views on an old problem or idea.

Creative thinking can also be defined as a person's cognitive process to generate ideas that are effective in solving problems under certain goals and conditions (Glass, 2004; Kadir et al., 2017; Young & Balli, 2014). Creative thinking skills include imagination, independence, experimentation, etc. which are important aspects in the science learning process (Lince, 2016).

Creative thinking skill is one of the important abilities for students in accordance with national education goals (Sarwinda, 2012) and 21st century skills (Arbia et al., 2020). Someone who has the ability to think creatively is predicted to survive and succeed in future life. Someone who has the ability to think creatively. The catalyst theory proposed by McCrae and Ingraham states that the environment will stimulate students' intelligence. Students who study in a good environment such as in an urban area will be able to develop their creativity (Sugiharto et al., 2020), but other factors also affect their abilities such as personality, cognitive and genes (Shi et al., 2016).

In this study, the research instrument uses creative thinking indicators developed by (Guilfor, 1950) which were reformulated by Torrence (1974) namely originality, flexibility, elaboration and fluency (Ramón & López, 2021). Several studies using similar indicators as in (Oschepkov et al., 2022; Handayani et al., 2021) showed varying results with various perspectives. The Fluency indicator is in the good category with a percentage of 80.45%. Fluence is the ability to quickly generate many ideas, methods, suggestions, questions, ideas, solutions, or alternative answers within a certain time and emphasize quality (Aldalalah, 2020).

In contrast to the fluence indicator, the elaboration, flexibility and originality indicators are in fairly good indicators with a percentage of more than 60%. According to (Abraham et al., 2018) elaborative (details) is the ability to enrich, develop, add, elaborate, or detail the details of the object, idea, or situation so that it becomes more interesting. The elaboration indicator means the ability to develop new or existing ideas or ideas (Guilfor, 1950) while flexibility is the ability to make several creations differently for one challenge (Sani et al., 2019). According to (Asri et al., 2020) flexible, namely the ability to provide ideas or ideas for different answers with different points of view. Originality is the ability to be able to use ideas that are not commonly used or in unusual ways or in other words Originality can be interpreted statistically as answers that are rarely found from a certain population. So, an idea or product that is commonly found is not an original idea.

Conclusion

Based on the results of the study, it can be concluded that critical thinking skills are in the sufficient category with a percentage of 64.43% while students' creative thinking skills are also in the sufficient category with a percentage of 67.80% at Pekanbaru public senior high school in the quite good category.

Acknowledgements

Thanks to the Islamic University of Riau and all those who have helped the author in publishing this article, either directly or indirectly.

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