

# The analysis of creative thinking skills of junior high school students in learning natural science on environmental pollution materials with different academic skills

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**Abstract.** Pollution occurs when harmful substances are released into the environment. This study aims to analyze the creative thinking skills of junior high school students in natural science learning based on differences in students' academic abilities. This research is a descriptive study involving 118 8th grade students of junior high school. Students are classified into three categories; students with high, medium, and low academic ability. The results is academic skills directly proportional to creative thinking skills. Data shows that students with high academic abilities have high creative thinking skills. This is indicated by the average calculation result of all four elements of creative thinking by 33%. The students with moderate academic ability are also known to have creative thinking skills in the medium category, which is indicated by the average calculation result of the four elements of creative thinking by 26%. Likewise, students with low academic ability, have creative thinking skills in the low category with a percentage of 23%

## 1. Introduction

How to define Natural Science? Basically, natural science is a scientific discipline that uses the scientific method to study the independent and dependent variables of a natural event [1]. Nowadays, natural science is one of the core parts of school curricula around the world [2]. Education about Natural Sciences has several goals which include training skills critical and creative thinking [3]. In the current global education system, education about Natural Sciences is more than just fact – based knowledge [4]. One of the things learned in Natural Sciences is material about environmental pollution.

Environmental pollution is a form of contamination in physical and biological components that exist on earth so that it affects the normal processes in an environment [5]. Since the beginning of life, environmental pollution has been a part of it. However, it turned into a serious problem at this time that threatened the survival of humanity [6]. Pollution occurs when harmful substances known as contaminants are released into the environment, whether water, soil, or air, causing harm to humans or other living organisms [7]. Environmental pollution can be classified into several types including water, soil, air and noise pollution [8]. Each type of pollution has an impact. Air pollution for example. The impacts of air pollution include creating acid rain which causes deforestation, ozone depletion, acute respiratory infections, and so on [9].



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One solution to overcome these problems is to involve environmental education. Education takes the role as one of the main actor in solving environmental pollution problems because, with education, one's behavior and perspective can change positively [10]. Research conducted by Arani (2019) obtained the result that, environmental education in schools can increase student awareness of the importance of protecting the environment [11]. One important goal of environmental education is to provide an understanding of the importance of protecting the environment as well as possible and foster the ability to analyze environmental problems from various sides with critical and creative thinking [12].

Creativity has many definitions. The definition of creativity in many opinions generally always leads to one thing which is about 'producing something new or original' [13]. Creative thinking leads students to create and apply new ideas in specific contexts, see situations through different paths, provide alternative explanations, and create various new combinations with positive results [14]. Creative thinking skills must be cultivated and applied in all disciplines [15]. Today, it is important to allow students to practice problem-solving skills from the results of their thinking and use their ways to solve problems using different thoughts [16]. Other researchers conducted by Goodson, King, and Rohani (2015) revealed that developing creative thinking allows students to face challenges in their daily lives [17].

Creative thinking skills can be improved by making learning that practice students to be able to identify problems, design, to find solutions to their problems [18]. In line with Herayani (2015) that students' creative thinking skills can be trained by applying practices that hone creative thinking skills [19]. Students with creative thinking skills will demonstrate their skills in concepts determination, conveying conclusions, interpretations, assumptions, theories, definitions, and terms of reference [20]. The ability to make conclusions comes from logical thinking. Learning the mistakes and actions of others is one way to 'bring' logical thinking. Logical thinking will help students in difficult situations [21]. This study intends to analyze the level of creative thinking skills of junior high school students in learning natural science based on high, medium, and low academic abilities. This research is important because creative thinking skills are one important component that must be mastered by students to answer the challenges of the times. Another factor that makes this research important because the description of the quality of students' creative thinking skills is important as a reference for overcoming their learning difficulties. Besides, the results of the study can be used as a reference for evaluating the learning process, especially in junior high school students' science learning.

## 2. Methodology

The research is a study descriptive by applying mixed – method data analysis, namely quantitative and qualitative data analysis. Quantitative data were obtained from the results of creative thinking essays and qualitative data were obtained from the results of observations to determine the level of academic ability of students in terms of student ratings. This research involved 118 8th grade students of junior high school. Students' academic abilities obtained from observations are then classified into 3 categories: high, medium, and low. In this study, students who were ranked 1 to 8 were categorized as students with high academic abilities, students who ranked 9 to 16 were categorized as students with moderate academic abilities, and students who ranked 17 to the end were categorized as students with low academic abilities.

The material used for the creative thinking essay is the Environmental Pollution chapter material. The indicators used to make essay according to Guilford's (1967) creative thinking indicators, consist of 4 elements which include: (1) Fluency is related to the ability to come up with many ideas, (2) Flexibility is the ability to solve problems in various ways and not be repaired in one way, (3) Originality is the ability to produce something unique and authentic work, (4) Elaboration is the ability to describe ideas in as much detail as possible [22]. The results of scoring essay questions on creative thinking skills are then converted into percentage form using the following formula:

$$\text{Percentage (\%)} = \frac{\sum \text{Score Obtained}}{\sum \text{Maximal Score} \times 100\%}$$

The results of the percentage of creative thinking skills are categorized based on Riduwan's (2010) categorization in Table 1 as follows [23]:

**Table 1.** Criteria of creative thinking ability

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

**3. Result**

This research develops essay questions based on elements of creative thinking which include: fluency, flexibility, elaboration, and originality. The essays used in this study were validated. Examples of essay questions are in Table 2 as follows:

**Table 2.** Examples of essay questions on creative thinking skills

Element	Indicator	Question	Answer and Score
Elaboration	skill to describe some ideas in detail	Quoted from liputan6.com Arctic City Longyearbyen in the Norwegian archipelago has a unique rule that forbids its citizens to bury corpse there. This is because the Arctic City's air temperature is very low and the city has permafrost – type soil (land that can maintain cold temperatures). Relate this condition to the impact on the environment when the community forces the corpse to be buried there!	<p>The impact that occurred was the process of decomposing the corpse buried there did not occur. Decomposers can not work optimally especially for bacteria. If the temperature rises, the inactive bacteria become active. If many bodies are buried there, the decomposition process occurs in the almost same time, thus potentially causing pollution.</p> <p>Score 4: Students answer completely and correctly (explaining cause and effect accompanied by expressing the impact that will occur when the conditions in the question change)</p> <p>Score 3: Students answer completely and correctly (only explain cause and effect without expressing the impact that will occur when the conditions in the question change)</p> <p>Score 2: Students answer correctly (for example: just state the cause)</p> <p>Score1: Students answer but the answers are wrong</p>

Table 2 is one example of the questions used in the essay of this study. The question presented is a case study related to environmental problems. The questions presented can also be in the form of interesting facts about environmental conditions. The maximum score of each question is 5. The results of the calculation of scores obtained by students, then categorized into the category of creative thinking skills. Scores of students' answers to essays carried out are listed in Table 3 below:

**Table 3.** Mean of creative thinking skills score for each indicator based on students' academic ability (high, medium, low)

Academic Ability	Indicator				Mean
	Fluency	Flexibility	Elaboration	Originality	
High	31%	30%	45%	28%	33%
Moderate	23%	21%	33%	28%	26%
Low	15%	20%	30%	26%	23%
Mean	23%	24%	36%	27%	

Based on the number of samples, the percentage of creative thinking skills can be seen in table 4

**Table 4.** Percentage of students' creative thinking skills based on the number of samples

Creative Thinking Skills Levels	Academic Ability					
	High		Moderate		Low	
	N	%	N	%	N	%
Very Creative	1	3%	0	0	0	0
Creative	11	35%	1	3%	0	0%
Moderate	19	59%	14	44%	16	30%
Low	1	3%	17	53%	38	70%
Very Low	0	0	0	0	0	0

**4. Discussion**

This study provides assignments to students in the form of essays. The material used in this study is environmental pollution material. This material was chosen because environmental pollution is a global issue [24]. When students learn about environmental pollution, students indirectly learn the relevance of studies in the classroom with complex environmental problems. Students can acquire the skills they need to be creative problem solvers. This study uses an open essay by Guilford with four elements of creative thinking namely fluency, flexibility, elaboration, and originality. The essays is given in the form of case studies. One example of a case study presented in a student essay question is the case of the death of thousands of fish on Ancol Beach as a result of phytoplankton blooming [25]. Students are asked to analyze why fish deaths can occur.



**Figure 1.** Example of water pollution: death of thousands of fish on ancil beach

Table 3 shows the average results of each elements of creative thinking skills at each level of students academic abilities. These results indicate that generally, students have creative thinking skills that are in the low category. Based on the average value of the four indicators of creative thinking skills in table 3, it is known that academic skills directly proportional to creative thinking skills. The data in Table 3 shows that students with high academic abilities have high creative thinking skills. This is indicated by the average calculation result of all four elements of creative thinking by 33%. The students with moderate academic ability are also known to have creative thinking skills in the medium category, which is indicated by the average calculation result of the four elements of creative thinking by 26%. Likewise, students with low academic ability, have creative thinking skills in the low category with a percentage of 23%. This condition can occur because the ability of higher-order thinking skills level in junior high school students is not perfect. This is in line with research by Suratno (2018), students make a plan, revise and evaluate, but tend not to re-examine their opinions during planning, and students also do not provide logical reasons when determining steps in solving problems that are given [26].

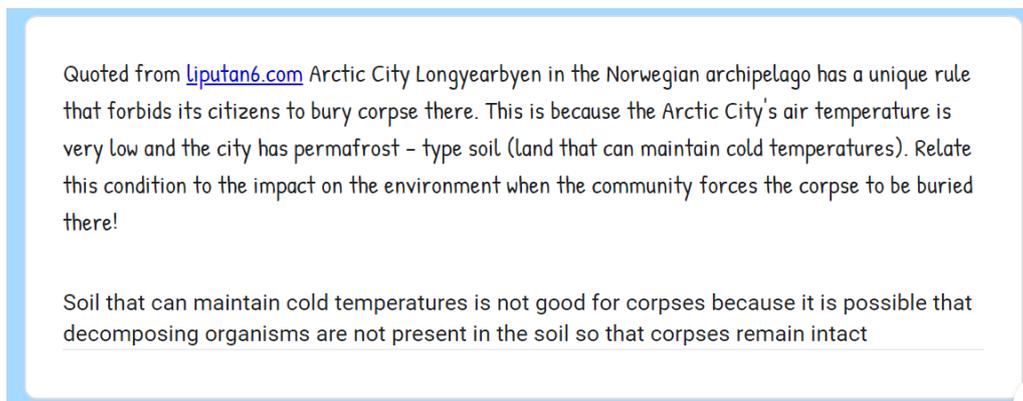
Based on the data in table 3, that of the four elements of creative thinking skills, students are weak in elements of fluency and flexibility. Thinking fluency can be defined as the number of unconventional and related ideas generated on a particular problem, or the number of associations produced in response to stimulants [27]. Meanwhile, flexibility is the ability to see problem in the question from different angles [28]. The results of this study indicate that the average creative thinking skills of students in the elements of Fluency and Flexibility are still relatively low with a percentage of 23% and 24%, respectively. The examples of student answers related to problems in the elements of fluency can be seen as follows. Students' answers theoretically have led to the correct answers but have not demonstrated the ability to think creatively in fluency elements. This can be seen from the answers of students who have not shown novelty in expressing solutions to problems in questions.

Quoted from Kompas.com in 2015 there were tens of thousands of fish deaths along Ancol Beach as a result of the explosion in the phytoplankton population. Write down your analysis of why this can happen, and suggest solutions that can be done to overcome the condition!

Phytoplankton carries out photosynthesis which means they need oxygen. The explosion of the phytoplankton population causes oxygen in the sea to be small. The solution is not to dispose of factory waste at sea, because the waste contains chemical compounds that cause the explosion of phytoplankton populations

**Figure 2.** Example of student answers on fluency elements question

Originality is an ability to produce an exclusive and unusual product. Originality is a main of innovation, but originality is the weakest dimension of creativity in the school environment, especially in correcting answers [28]. Based on table 3, an average of originality element is 27%. This is because students answers have not shown anything unique or unusual. The last element is the elaboration. Elaboration is the ability to think about something in detail by adding contextual details as needed [28]. This element has a percentage of 36% and is the element with the highest percentage compared to the other three elements. Students answers to questions related to elements of elaboration are quite good. Students have been able to provide sufficiently detailed answers to the question. Below is an example of students answers to questions in elaboration element.



**Figure 3.** Example of student answers on fluency elements question

Table 4 presents students' creative thinking skills based on the number of samples. Of the 32 students with high academic ability, the results showed that 1 student (3%) had creative thinking skills in the very creative category, 11 students (34%) were in the creative category, 19 students (59%) were in the moderate category and 1 student (3%) are in the low category. Meanwhile, in the category of moderate academic ability, creative thinking skills data were obtained: 1 student (3%) had creative thinking skills in the creative category, 14 students (44%) were in the moderate category and 17 other students (53%) were in a low category. While students with low academic ability are known to be 30% students or as many as 16 students out of 54 students have creative thinking skills in the medium category, and the remaining 70% (38 students) have creative thinking skills in the low category.

The results of this study are in line with research conducted by Anwar et al., (2012) which states that that between creative thinking abilities and student achievement have a positive relationship [29]. Saragih and Napitupulu (2015) also support the results that by knowing students' creative thinking abilities, academic achievement can be predicted [30]. A similar study of 72 subjects was carried out by Nami et al., (2014). The results showed that there was a positive relation between academic ability and the creative thinking skills of students [31]. Many factors influence students' creative thinking skills including group activities [32], learning environments [33], technology [34], and visual vision.

## 5. Conclusion

In terms of each element of creative thinking, students with all three academic categories in this study, still classified as having creative thinking skills in the low category. Based on the average value of the four elements of creative thinking it can be concluded that academic ability will tend to be directly proportional to creative thinking skills. The data shows that students with the high academic ability also have high creative thinking skills. Calculation of the mean value of creative thinking elements which shows 33% indicates the condition. Students with moderate academic abilities also have creative thinking skills in the medium category, indicated by the average calculation results of the four elements of creative thinking with a percentage of 26%. Likewise, students with low academic ability have creative thinking skills in the low category with a percentage of 23%.

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## References

- [1] Gorelov A A 2003 *Concepts of modern natural sciences: A textbook for universities* (M: VLADOS center)
- [2] Taber K S and Akpan B 2017 *Science Education: An International Course Companion* (Boston: Sense Publisher)

- [3] Clough M P 2015 A Science Education that Promotes the Characteristics of Science and Scientists *K – STEM Education*. **1** 23 – 29
- [4] Jessani S I 2015 Science Education: Issues, Approaches and Challenges *Journal of Education and Educational Development*. **2** 79 – 87
- [5] Muralikrishna I V and Manickam V 2017 *Introduction. Environmental Management*, 1–4. Elsevier Inc.
- [6] Madaleno M 2018 Environmental Pollution, Waste Generation and Human Health *Biomedical Journal of Scientific & Technical Research*. **8** 6560 – 62
- [7] Obafemi A A, Eludoyin O S, and Akinbosola B M 2012 Public Perception of Environmental Pollution in Warri Nigeria. *Journal of Applied Sciences and Environmental Management*. **16** 233 – 240.
- [8] Kumar R S, Arumugam T, Anandakumar C R, Balakrishnan S and Rajavel D S 2013 Use of Plant Species in Controlling Environmental Pollution – A Review *Bulletin of Environment, Pharmacology and Life Sciences*. **2** 52 – 63
- [9] Ress N 2016 *Clear The Air For Children: The Impact Of Air Pollution On Children* (United Nations Children’s Fund (UNICEF))
- [10] Karatas A 2013 The Role of Faculties of Education in Increasing Sustainable Environmental Awareness of Society *European Journal of Sustainable Development*. **2** 233 – 242
- [11] Arani M H, Bagheri S, and Taghi G M T 2019 The Role of Environmental Education in Increasing the Awareness of Primary School Students and Reducing Environmental Risks. *Journal of Environmental Health and Sustainable Development*. **1** 9 – 17.
- [12] Safari Z, Shimanaderi, and Zahraghasemi 2014 Examine The Role Of Education In Reducing Environmental Pollution *Indian Journal of Fundamental and Applied Life Sciences*. **4** 1178 – 83
- [13] Torrance E P 1966 Rationale of the Torrance tests of creative thinking ability. In Torrance, E. P. and W. F. White (eds.). 1969. *Issues And Advances In Education Psychology*. Istica, IL: F. E. Peacock.
- [14] Mursky C 2011 Creative Thinking. <https://dpi.wi.gov/sites/default/files/imce/cal/pdf/creative-thinking.pdf>.
- [15] UNESCO International Bureau of Education 2014 Creativity. In *Guiding Principles for Learning in the Twenty First Century* (p. 15 – 18). Retrieved from [www.ecolint.ch/file/621/download?token=zhQH7qg](http://www.ecolint.ch/file/621/download?token=zhQH7qg).
- [16] D Nurhamidah, M Masykuri and S Dwiastuti 2018 Profile Of Senior High School Students Creative Thinking Skills On Biology Material In Low, Medium, And High Academic Perspective. *Journal of Physics Conf. Series* 1006.
- [17] Goodson L, King F J and Rohani F 2015 Improving Student’s Higher-Order Thinking Competencies, Including Critical Evaluation, Creative Thinking, And Reflection On Their Own Thinking (Level, Declarative Knowledge, Plan, Quality Enhancement) *Research in Science Education*.
- [18] Nuha M A, Waluya S B and Iwan J 2018 Mathematical Creative Process Wallas Model in Students Problem Posing with Lesson Study Approach. *International Journal of Instruction*. **11** 527 – 538.
- [19] Herayani, Kartono and Sukestiyarno Y L 2015 Analisis Berpikir Kreatif Matematis dan Karakter Rasa Ingin Tahu pada Pembelajaran SSCS Berbantuan Media Puzzle Materi Pecahan *Journal of Primary Education*. **4** 96 – 103.
- [20] Paul R and Elder L 2011 Critical Thinking: Competency Standards Essential for the Cultivation of Intellectual Skills, Part 3. *Journal of Development Education*. **35** 34 – 35.
- [21] Zhao S 2009 The Nature And Value Of Common Sense To Decision Making. *Management Decision*. **47** 441 – 453
- [22] Drapeau P 2009 *Differentiating With Graphic Organizers: Tools To Foster Critical And Creative Thinking* (Thousand Oaks, CA: Corwin)

- [23] Riduwan 2010 Skala Pengukuran Variabel – Variabel Penelitian (Bandung: Alfabeta)
- [24] Kamimura A, Armenta B, Nourian M, Assasnik N, Nourian K, and Chernenko A 2017 Perceived Environmental Pollution and Its Impact on Health in China, Japan, and South Korea *Journal of Preventive Medicine and Public Health*. **50** 188–194.
- [25] Vimono I B 2015 Booming Fitoplankton Penyebab Ikan Mati di Ancol. <http://lipi.go.id/berita/single/Booming-Fitoplankton-Penyebab-Ikan-Mati-di-Ancol/12261>.
- [26] Suratno and Kurniati D 2018 The Analysis of Higher Order Thinking Skills in Solving the Real Problem of the Coffee Plantation Area Students *Advanced Science Letters*. **24** 2199 – 202
- [27] Karakelle S 2009 Enhancing Fluent And Flexible Thinking Through The Creative Drama Process *Thinking Skills and Creativity*. **4** 124 – 129.
- [28] Shively C H 2011 *Grow Creativity!* (Canada: International Society for Technology in Education)
- [29] Anwar N M, Aness M, and Khizar A 2012 Relationship of Creative Thinking with Academic Achievements of Secondary School Students *International Interdisciplinary Journal of Education*. **1** 12–24.
- [30] Saragih S, and Napitupulu E 2015 Developing Student-Centered Learning Model to Improve High Order Mathematical Thinking Ability *Canadian Center of Science and Education*. **8** 104 – 112
- [31] Nami Y, Marsooli H, and Ashouri M 2014 The Relationship Between Creativity And Academic Achievement *Procedia - Social and Behavioral Sciences*. **114** 36 – 39.
- [32] Eslami G R, Hanachi P, and Kamelnia H 2009 Analysis And Comparative Study Of Community, Social, And Participatory Architecture *J. Archit. Urban Plan. (Fine Arts)*. **39** 47 – 60.
- [33] Cho J Y 2017 An Investigation Of Design Studio Performance In Relation To Creativity, Spatial Ability, And Visual Cognitive Style. *Thinking Skills and Creativity*. **23** 67 – 78.
- [34] Robertson B F and Radcliffe D F 2009 Impact Of Cad Tools On Creative Problem Solving In Engineering Design *Computer Aided Design*. **41** 136 – 146.