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The Profile of Creative Thinking Skills of Junior High School Students in Science Learning About Alternative Energy

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Abstract: This research aims to explore junior high school students' creative thinking skill profile in science learning about alternative energy. This research was a quantitative descriptive essay test method. Respondents were 128 7th-grade junior high school students in Jember, East Java, Indonesia. The essay test consists of eight open-ended questions. Every indicator of creative thinking skill consists of two questions number. The Test score would be analyzed by IBM SPSS Statistic 23 using descriptive analyses, frequency analyses, one-sample Kolmogorov-Smirnov tests, validity tests by Pearson correlation, reliability tests, linearity tests, and regression analyses. The results showed that the creative thinking skills of junior high school students were unsatisfactory. Creative thinking skills still need improvement in science learning. Some students had challenges finding and designing a unique creative work on alternative energy. The results of this study implied that creative thinking skills must improve by developing learning methods, strategies, activities, approaches, media, context, and interaction in the discussion process.

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Introduction

The skills needed for education have been labeled 21st-century skills (van Laar, van Deursen, van Dijk, & de Haan, 2020). There are three essential components of 21st-century skills: IMT (Information, Media, and Technological), learning and innovation, and life and career skills. Teachers must focus on developing these skills in the teaching process. The most accessible place for teachers is to address the benefits of 21st-century skills (Hadinugrahaningsih, Rahmawati, & Ridwan, 2017) by paying attention to one of the vital skills in this 21st century, which is creativity. Creativity is related to producing new and valuable ideas on products, services, or processes that are both novel and potentially useful (van Laar et al., 2020), usually called creative thinking skills. Creative thinking skills can determine the power to exhibit creative behavior (Guilford, 1950), identify a task or problem (Sirajudin, Suratno, & Pamuti, 2021), and utilize the knowledge for problem-solving and decision-making (Wijayati, Sumarni, & Supanti, 2019). With creative thinking skills, students can create a solution that requires assumptions and arguments, realize the value of repeatable data collection on science experiments, and foster another talent, such as a scientific presentation.

Creative thinking skills include flexibility, fluency, originality, and elaboration. Fluency is indicated by the ability to solve with some ideas (Huang, Chang, & Chou, 2020) that are given quickly (Sugiyanto, Masykuri, & Muzzazinah, 2018). Flexibility is indicated by abilities to generate a solution from different points of view (Sirajudin et al., 2021), different ways (Huang et al., 2020), approaches (Sugiyanto et al., 2018), and perspectives

Jurnal Paedagogy:
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Vol. 10 No. 3 : July 2023
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pp. 675-682

(Nurhalizah, Zubaidah, Mahanal, & Setiawan, 2020) to answer questions. Originality is indicated by abilities to show unique expressions (Sirajudin et al., 2021) and original solutions (Wijayati et al., 2019). The unique expressions or original solutions are usually not commonly found in references or submitted by people (Nurhalizah et al., 2020). Elaboration is indicated the level of detail describing an argument (Huang et al., 2020), link one information with those from different disciplines (Wijayati et al., 2019), developing detailed ideas (Sugiyanto et al., 2018), itemizing ideas or answers given (Nurhalizah et al., 2020), and add meaning to the argument put forward (Alfitriyani, Pursitasari, & Kurniasih, 2021).

The central role of teachers in education is to make meaningful learning for students. The teacher must develop a learning scenario considering the level of creative thinking skills and their aspects. Teachers can simultaneously support creativity with their academic knowledge (Yayuk, Purwanto, As'Ari, & Subanji, 2020) and analyze creative thinking skills. If teachers know the fulfilled status of each and analyze creative thinking skills. If teachers know the fulfilled status of each innovative thinking skill aspect, the learning scenario will be generated and focus on specific things that need to increase. The learning process can be carried out by giving students opportunities to learn so that creative thinking skills can develop actively. Learning stages can be designed concerning the characteristics of thinking skills. Instructional design can also consider teaching resources that lead to physical and mental activity so that thinking skills can continue to improve.

One of the most critical subjects in school is science. Teachers are responsible for teaching how to apply science in daily life. Science knowledge must be used to solve environmental problems. One of the most crucial ecological problems is energy. Fortunately, energy is one of the materials in science. Students in Indonesia junior high schools will learn about energy in 7th grade. The increasing energy demand desperately requires alternative energy sources due to the explosive development of industrialization in many countries (Hasran, Pauzi, Basri, & A. Karim, 2018). The teacher must guide students to realize that alternative energy is essential and encourage them to create the solution. In addition to science content knowledge, environmental issue has the most attention. The youths in all regions demonstrated a broader understanding of science as a discipline with specific norms and practices (Ballard, Dixon, & Harris, 2017). Practices as a process of creating solutions need creative thinking skills. This research aims to explore the creative thinking skills of junior high school students in science learning about alternative energy. Teaching and learning scenarios about alternative energy can be created effectively using student's characteristic of creative thinking skills. Teachers can design learning steps and student learning activities by considering initial skills.

Research Method

This research was quantitative descriptive research. The data collecting technique was the essay test technique. The essay test consisted of eight questions. Two questions present each aspect of creative thinking skills. An expert in science learning has validated the essay test and assessment rubric. The sample of this research was 7th-grade students of junior high school in Jember, East Java, Indonesia. One hundred ten participants contributed to this research. Each maximum and minimum scores on the essay test are 12 and 0, respectively. The total score of the essay test calculates by the sum of the score of each test. The range of the total score was 0 to 96. The level of creative thinking skills calculates by converting the entire score to a percentage and indicates the class based on Table 1. Each indicator is measured by ratios and shown based on Table 1.

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Vol. 10 No. 3 : July 2023
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pp. 675-682

Table 1. Criteria Of Creative Thinking and Each Indicator

Percentage	Criteria
76% - 100%	High
51% - 75,99%	Sufficient
26% - 50,99%	Low
0% - 25,99%	Very Low

Data were analyzed by IBM SPSS Statistics 23. Analyses used in SPSS were descriptive analyses, frequency analyses, one-sample Kolmogorov-Smirnov tests, validity tests by Pearson correlation, reliability tests, linearity tests, and regression analyses. Descriptive analyses will show the range and mean of data. Frequency analyses will show the amount of each essay test score. The literature of earlier research and regression analyses between gender and creative thinking skill value will analyze factors that affect creative thinking skills. Terms for regression analyses are normal, valid, reliable, and linear. One sample Kolmogorov-Smirnov test will show significant value and mention either its normal distribution or not. The validation Pearson test will show significant value and mention its validity. The reliable Cronbach alpha test will show significant value and note whether faithful. The linearity test by deviation from the linearity value will show whether it is linear.

Results and Discussion

Creative thinking skill was measured by an essay test of eight open-ended questions. Every two questions will figure out one aspect of creative thinking skills. The element of creative thinking skills is flexibility, fluency, originality, and elaboration. One hundred and twenty-eight students from 7th grade already fill the essay test and analyses using descriptive, as shown in Table 2. The frequency of each score also showed in Figure 1.

Table 2. Analyses Descriptive of Test Score

	N	Min.	Max,	Mean	Std. Dev.
Score	128	9	49	27.78	7.33
Valid N (listwise)	128				

Table 2 shows that the mean score of the essay test is 27.78. This result indicates that the creative thinking skills of students are low. It is consistent with the earlier research that states that creative aspects need to be also developed appropriately and that creative thinking skill level is relatively classified as low (Kark, Van Dijk, & Vashdi, 2018; Sugiyanto et al., 2018; Wijayati et al., 2019). Based on earlier research, creative thinking skills are affected by intelligence (Sugiyanto et al., 2018), characters (Ela, Yenni, Amali, & Sari, 2019), and teaching abilities (Isnawati, Jalinus, & Risfendra, 2020).

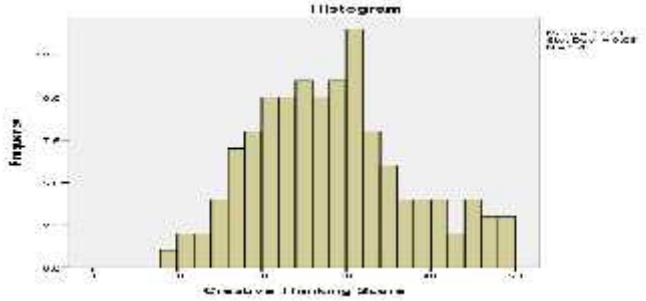

Figure 1. Histogram of the score of creative thinking skills

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https://e-journal.undikma.ac.id/index.php/pedagogy/index
Email: paedagogy@undikma.ac.id

Vol. 10 No. 3 : July 2023
E-ISSN: 2722-4627
pp. 675-682

Figure 1 shows the data range distribution. The histogram shapes are similar to the normal curve, indicating that the data distribution is normal. The sample of this research is random, and gender is the only different factor because the sample is not divided into intelligence, character, and teaching by professional teachers. Analyses are needed to find either gender implicated in creative thinking skills. Regression analyses are applied to see the effect of gender on creative thinking skills and describe another factor that affects creative thinking skills. Several terms must be fulfilled because variables have to be normal, valid, reliable, and linear.

Table 3. Value Terms Regression Analyses

Test	Value	Condition	Result
One sample kolmogorov-smirnov	Significant	If sig. > 0.05, variables are normal If sig. < 0.05, variables are not normal	Sig. = 0.20 Sig. > 0.05 Variables are normal
Pearson	Significant	If sig. < 0.05, variables are valid If sig. > 0.05, variables are not valid	Sig = 0.00 Sig. < 0.05 Variables are valid
Reliable	Cronbach alpha	If Cronbach alpha > 0.6, the variables are reliable If Cronbach alpha < 0.6, variables are not reliable	Cronbach alpha = 0.678 Cronbach alpha > 0.6 Variables are reliable
Linearity	Sig. deviation from linearity	If sig. > 0.05, variables are linear. If sig. < 0.05, variables are not linear.	Sig. = 0.588 Sig. > 0.05 Variables are linear

Table 4. Regression Analyses

	Significant	R Square
Model Summary		.005
ANOVA	.344	

Based on Table 3, all terms are fulfilled. There were 50 male students and 78 female students. Based on Table 4, gender affected creative thinking skills by a percentage 0.5%. The Sig in Table 4 is 0.344 and higher than 0.05, which means gender does not affect creative thinking skills. There are various solutions to developing creative thinking skills. Based on earlier research, innovative thinking will improve by being involved in the ethno-STEM PBL (Wijayati et al., 2019), giving project briefs (Habibi et al., 2020), creativity training program (Ritter, 2020), ICT-based learning resources (Nurhidayat & Fayanto, 2022), offline practicums (Prihanta & Purwati, 2022), hybrid learning strategy (Zb, Setiawan, Rozal, & Sulman, 2021), and Hybrid-PjBL (Rahardjanto, Husamah, & Fauzi, 2019).

Table 5. Mean Score of Essay Test

Indicators	Test number	Mean
Fluency	1	40.86
	2	42.28
Flexibility	3	22.27

Jurnal Paedagogy:
Jurnal Penelitian dan Pengembangan Pendidikan
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Email: paedagogy@undikma.ac.id

Vol. 10 No. 3 : July 2023
E-ISSN: 2722-4627
pp. 675-682

	4	23.64
Originality	5	17.98
	6	18.85
Elaboration	7	27.37
	8	28.91

Table 6. Analyses Descriptive of Each Indicator

Indicators	Percentage (%)	Level
Fluency	41.57	Low
Flexibility	22.95	Low
Originality	18.41	Very low
Elaboration	28.14	Low

The aspect of fluency determines the ability to create ideas and answer in a short time. The students of junior high school have a low level of fluency ability. Either in test number 1 or 2, students find it difficult to generate many answers in a short time, but this result is the highest indicator than others. There is potential to improve fluency ability in science learning. The aspect of flexibility determines the ability to create answers and solutions from different points of view, ways of thinking, and approaches. The students of junior high school have a low level of flexibility. In test number 3 or 4, students find it challenging to generate answers from another process or point of view and make another way of thinking. The originality aspect determines the ability to create unique solutions in courses. The students of junior high school have a deficient level of uniqueness. Students find test number 5 more difficult than number 6. In this question, students must find their unique ideas about another function of new energy without guidance. Test number 6 advises students that finding something special in their environment with their way of thinking is easier. Elaboration determines the ability to describe ideas in detail and itemize. Junior high school students need a higher level of elaboration. It means they find it challenging to explain their thoughts about energy-converting phenomena and develop them in detail.

In the aspect of fluency, students are asked to provide answers in the form of brief ideas about energy sources and components of hydroelectric power within a specific time limit. Based on Table 5, it is easier for students to give short ideas about power plant components than energy sources. The students achieved the highest score in solving the fluency-type problems (Wijayati et al., 2019). These results can be a consideration for teachers to introduce more about various energy sources.

qRegarding flexibility, students are asked to provide answers in the form of ideas related to two specific conditions regarding forms of energy. Based on Table 5 and Table 6, the average aspect of flexibility is low and has a difference of 18.65. Students find it more challenging to provide ideas related to two specific conditions than short ideas. The teacher must consider this condition to provide learning and exercises under flexibility. The students have begun to show flexibility and elaboration abilities by thinking flexibly and broadly in arguments (Wijayati et al., 2019). Students can be trained to see a condition from various points of view and solve problems using more than one solution and different approaches.

In the originality aspect, students are asked to provide unique ideas that are rarely found regarding the use of new energy and energy sources. The element of originality has the lowest achievement. This condition shows that students have difficulty finding ideas that are unique and difficult to find. Students tend to write down general statements that are easy to find. Teachers can pay more attention to increasing originality by providing new views and

Vol. 10 No. 3 : July 2023
E-ISSN: 2722-4627
pp. 675-682

ways to help students offer unique ideas. The ability to think creatively in offline practicums is higher than in online training in originality and fluency (Prihanta & Purwanti, 2022).

Students are asked to explain photosynthesis and wind power generation phenomena in the elaboration aspect. The achievement of thinking skills in the elaboration aspect is low. Students have difficulty explaining the causes and consequences of the phenomenon of photosynthesis and wind power generation. Students tend to present only effects or causes and need help to relate them. This condition needs to be a concern for teachers to provide science learning about energy and its changes phenomena. The ability to explain with a cause-and-effect relationship requires combining brief ideas. Elaboration also shows the power of students to describe these straightforward ideas.

Several factors can cause the low creative thinking skills of students in learning. Teachers paying less attention and implementing cognitive strategies can cause students to be less able to develop thinking skills (Ritter, 2020). Minimal and less innovative learning resources can cause students to be less motivated in learning to develop thinking skills (Daga, Wahyudin, & Susilana, 2022). Activities such as observation, experiments, and field trips, enable students to learn on their own, more easily understand the lessons, show a positive attitude toward science, and develop their creativity (Wijayati et al., 2019). Under high renewable energy penetration, neglecting the short-term constraints may lead to plans significantly short on flexibility (Abdin & Zio, 2018). Alternative energy can be a suitable science content to develop creative thinking skills. Table 6 shows that students could make an original design with a guide. This idea can be implemented in learning scenarios by guiding students to design alternative energy systems step by step. Furthermore, if students accept much guidance, they can make their original design without advice.

The implications of the results of this study that creative thinking skills must improve. Each indicator of creative thinking skills can be included in learning approaches, learning models, learning methods, student assignments and projects. Based on the results of the study, the originality indicator is in a very low category, so special attention should be paid. Teachers can compile worksheets that train students' creative thinking skills through a project, combine several learning approaches and models that are appropriate to indicators of creative thinking skills, and compile materials and interactive learning media to support student activities in improving creative thinking skill.

Conclusion

The profile of creative thinking skills of junior high school students about alternative energy in science learning measured by essay tests is low level. Four indicators are used to measure creative thinking skills: fluency, flexibility, originality, and elaboration. Fluency, flexibility, and elaboration are measured at a low level, but originality is measured at a deficient level. It takes the point that improving creative thinking skills will be crucial for teachers, especially in originality indicators. The results of this study imply that to improve the creative thinking skills of junior high school are developing learning methods, strategies, activities, approaches, media, context, and interaction in the discussion process.

Recommendation

There are several recommendations based on research results. Teachers can develop and design learning methods, strategies, activities, approaches, media, context, and interaction in the discussion process. Applying ICT in the learning process will be good innovation to improve creative thinking skills. Teachers can use specific technologies in the teaching

Vol. 10 No. 3 : July 2023
E-ISSN: 2722-4627
pp. 675-682

process, such as flip books, augmented reality, educational games, and interactive multimedia.

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