Student Scientific Creativity Profile Based on Scientific Structure Creativity Model

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Abstract. Creativity is an important skill for student in 21st century. Creativity is the ability to make some new ideas or products that are unique and useful. Scientific creativity links creativity and science, includes science process and science product. Scientific creativity is useful for understanding scientific phenomena, advancing science knowledge, solving scientific problem and producing scientific product. The aim of this research was to identify the profile of students' scientific creativity. This research was conducted by a descriptive research method. The subject of this research was 30 students from grade VIII of Junior High School Y Surakarta. The data of students' scientific creativity was collected using 7 item scientific creativity test related to the Scientific Structure Creativity Model (SSCM) by Hu and Adey. The test was carried out to obtain the personality traits of scientific creativity includes fluency, flexibility and originality. The result showed that the percentage of students' scientific creativity achievements are: fluency 56.17%, flexibility 44.64% and originality 30.63%. Based on the result, the average of students' scientific creativity was 43.81%. This indicated that the students' scientific creativity was in low level, therefore scientific creativity must be a serious concern in the science learning process. Teachers should use a learning model that can develop students' scientific creativity.

Keywords: creativity, fluency, flexibility, originality

1 Introduction

As the implication of advanced technology, the challenge of education nowadays is to be able to produce individuals to compete in the 21st century era, namely the era of rapid development of information and communication technology. P21 Partnership for 21st Century Learning states that 21st century learning needs to develop learning and innovation skills including communication, critical thinking and problem solving, collaboration, creativity and innovation [1]. Creativity is considered as the main component of human intelligence and life skills that are very important in student education [2].

Creativity was first explained by Guildford. According to Guildford, creativity is included in divergent thinking which leads to several answers rather than converging that lead to one answer. Creativity defined as cognitive process that support to produce novel and useful ideas [3]. Creativity is the ability to make something new as a prerequisite for innovation [4]. Creativity is the process, results, and products of efforts to develop new and better ways of doing things [5]. Every human being has the ability to apply thought and imagination by bringing new ideas into real products [6].

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Creativity in science is not the same as creativity in general. Science is a field of knowledge about facts, phenomena, law, theory and application. Science is a product and also a process [7]. Creativity is associated with science so that the term scientific creativity appears. Scientific creativity is included in divergent thinking but emphasizes finding and solving scientific problems, scientific investigations and creative science activities [8]. Scientific creativity is the ability to produce ideas or product that are relevant to context and have scientific advantage [9]. Scientific creativity is an intellectual skill to produce certain original products, of social and personal value, designed with specific objectives using the information provided [10]. Hu and Adey (2002) states that there are five hypotheses related to scientific creativity structure. First, the distinctness of scientific creativity from other creativity lies on the experiments, problem solving, and doing activities related to creative science. Second, scientific creativity structure can be influenced by non-intellectual factors though its structure is not a non-intellectual factor. Third, Skills and scientific knowledge are two most essential aspects on scientific creativity. Fourth, developmental and static structures are the building blocks of scientific creativity. Fifth, the mental ability including creativity and analytical intelligence are two factors that are dissimilar.

To measure scientific creativity in students, it is not suitable if using a question in the form of multiple choices but should be in the form of questions that make students able to think divergently [11]. To measure students' scientific creativity, Hu & Adey designed a three-dimensional Scientific Structure Creativity Model (SSCM) presented in Figure 1[10].

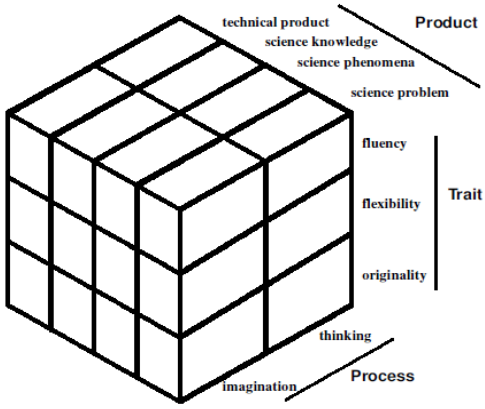


Fig. 1. Scientific Structure Creativity Model (SSCM)

The measurement model of scientific creativity according to Hu and Adey consists of 3 dimensions, namely personality trait, scientific product and scientific process. Trait dimensions include fluency, flexibility and originality. Fluency shows productivity in giving ideas, flexibility shows a variety of ideas given in creative problem solving [12] while originality shows the new or unusual of ideas given, the high ability of creative people [13]. The dimensions of science products consist of (1) technical products, namely the results of scientific discovery or research processes, (2) the development of scientific knowledge, (3) understanding of scientific phenomena, and (4) providing solutions to scientific problems. The dimensions of the process of scientific creativity include creative thinking and creative

imagination [14]. These three dimensions form the basis for measuring students' scientific creativity.

2 Method

This study aims to determine the profile of scientific creativity of students. The subjects of the study were eighth grade students of junior high school YSurakarta with a total of 30 students. The research was carried out by descriptive method. The instruments used were 7 items of scientific creativity tests based on the Scientific Structure Creativity Model (SSCM) developed by Hu and Adey. The SSCM model combines 3 dimensions, namely trait, product and process. Each test item given measures indicators of scientific creativity traits, namely fluency, flexibility and originality. Fluency is measured in items no 1-4. Giving fluency scores is done by looking at the number of student answers. Flexibility is measured in item tests 1 to 7. Flexibility scores are measured by looking at students' answers from the perspective of different answers. Originality is measured on items test number 1 to 7. Assessment is done by tabulating student answers that match the question in question and different from other students. Assessment of scientific creativity is done by adding fluency scores, flexibility and originality to each test item. The sum of these scores is then made a percentage of the achievement of students' scientific creativity on each item and as a whole.

3 Results and Discussion

Scientific Structure Creativity Model (SSCM) by Hu and Adey measures students' scientific creativity based on 3 components, namely traits, science product and science process. Traits are the attitudes that exist in someone who is creative including fluency, flexibility and originality. Science product is something that is produced from creative processes including science knowledge, science problems, science phenomena and technical products. This science product can also be used to enhance the creative attitude of students. Scientific process is a process that occurs in the brain of students to produce a science product with the process of thinking and imagination.

The results of the scientific creativity test of students using the 7-item SSCM test model by Hu and Adey for each test item are presented in **Table 1**.

Table 1. Test Results in Percentage of Students' Scientific Creativity

Item test	Product	Process	Trait	Percentage (%)
1	Science knowledge	Thinking	Fluency	56.67
			Flexibility	54.17
			Originality	23.33
2	Science problem	Thinking	Fluency	66.00
		Imagination	Flexibility	62.50
			Originality	46.67
3	Technical product	Thinking	Fluency	57.33
		Imagination	Flexibility	52.50

			Originality	35.33
4	Science phenomena	Imagination	Fluency	44.67
			Flexibility	39.67
			Originality	18.67
5	Science problem	Thinking	Flexibility	52.50
		Imagination	Originality	30.00
6	Science phenomena	Thinking	Flexibility	21.85
			Originality	25.56
7	Technical product	Thinking	Flexibility	29.78
		Imagination	Originality	30.67

The following is a description of the students' questions and answers for test items number 2 and 7

Item Number 2

> If you can take a plane to travel into space and go to a certain planet, what scientific questions will you ask to study? Write as many scientific questions as possible.
> For example: are there the living beings on the planet?

Test item number 2 aims to measure students' sensitivity to scientific problems. To make scientific questions with a new perspective, a thought and imagination process is needed. Item number 2 measures fluency, flexibility and originality. The SSCM includes problems x fluency, flexibility and originality x thinking and imagination consisting of 6 cells. The SSCM designs are expressed in Figure 2.

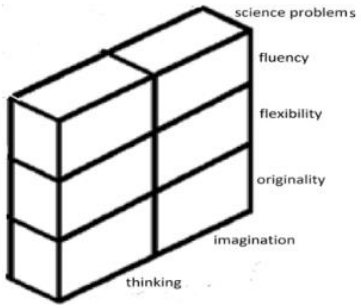


Fig. 2. Design of SSCM in 6 Cells for Item Number 2

The following are examples of students' answers:

Table 2. Students' Answer for Item Number 2

Student 1	Student 2
a. Can we stay alive and survive in this planet?	a. Is there any human in this planet?
b. How is the temperature in this planet?	b. How is the condition of this planet?
c. How is the vegetation of the land? Is it fertile or not?	c. What star that has been centered by this planet?
	d. What is the satellite of this planet?
	e. How is the temperature in this planet?
	f. Is there any water in this planet?

	g.	Is there any atmosphere in this planet?
	h.	What are this planet consisted of? What is the layers?
	i.	Is this dangerous to live in this planet?

Based on **Table 2**, first students give 3 answers according to the scientific question so that the score of fluency is 3. The students' answers "Can we stay alive and survive in this planet?" has the same point of view with the answers exemplified so that the scores given for flexibility is2. The first students' answer shows that students have low scientific creativity in solving scientific problems. The second students' provide answersrelated to scientific questions with more numbers. Students provide 9 scientific answers with different points of view. Studentsprovide answers smoothly, flexibly and some original answers in solving scientific problems presented. Second Student answers show that students have high scientific creativity in solving scientific problems.To solve the scientific problems, students must combine creative imagination and logical analysis [15]. Sometimes, students can imagine to solve the problems but not in logic. Teacher must guide the student uses modelling and questioning so that student can give the best solution for the scientific problem.

Item Number 7

Make a design for an orange picker. Draw and show the name and the function of each part of the design tool you have made.

Itemtest number 7 aims to measure students' ability to design scientific products. SSCM includes: technical product flexibility and originality thinking and imagination consists of 4 cells. The SSCM designs are expressed in Figure 3:

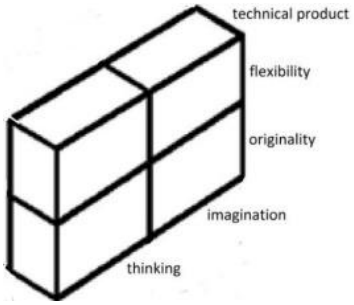
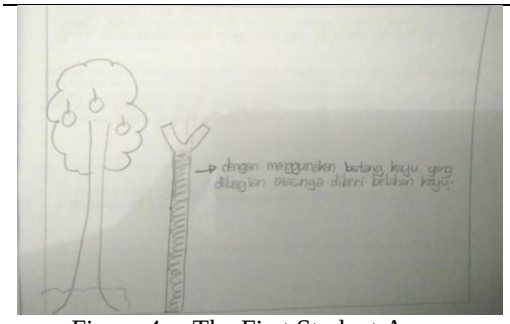


Fig. 3. Design of SSCM in 6 Cells for Item Number 7

The following are examples of students' answers:

Table 3. Students' Answer for Item Number 7

Students's Answer	Explanation in English
 Figure 4.a. The First Student Answer	The first student drew the orange tree with the fruits full of it. Then the students also drew the tool from wood to take the fruits down. This is a simple mechanism of picking orange.
 Figure 4.b. The Second Student Answer	The second student drew the whole process of orange harvest. The student drew the orange picker which was more complicated tool than the usual wood. The student also drew the complete mechanism until the oranges were carried out in the car. There were a lot of people in the drawing.

Scoring on item number 7 based on the function of orange pickers includes the ability to reach oranges, find oranges, pick oranges, move oranges to the ground, sort oranges, put oranges into containers and move from one tree to another. The students' answer in Figure 4.a is the answer given by many students, namely using poles as a tool for picking oranges. This shows that many students have not been able to think and imagine to make science products that facilitate human activities. Scientific creativity of students in making low science products is shown by the low percentage of student flexibility in item test number 7 of 29.78% and originality of 30.67%. Student answers in Figure 4.b show better answers. Students can think and imagine well to make science products. Students have shown some functions of the machine including parts to reach oranges, orange cutters with scissors and lasers, collecting oranges, orange peeler and the machine can move from one tree to another. But there are still some shortcomings including the orange picker is less effective when using scissors because it will take a long time.Process of designing creative product include asking, imaging, planning, creating and improving [16]. Some student can't imagine how is the orange pickers so they can't plan, create and improve the design of orange pickers.

Below is the summary of the results of students' scientific creativity tests for each personality trait is presented in **Table 4**.

Table 4. Summary of Test Result in Students' Scientific Creativity

Scientific Creativity Traits	Percentage(%)
Fluency	56.17
Flexibilty	44.64
Originality	30.63
Average	43.81

Based on **Table 4**. the percentage of fluency 56.17%, flexibility 44.64% and originality 30.63%. The percentage of fluency was better than the percentage of flexibility and originality. Fluency was the lowest ability and originality was the highest ability of scientific creativity [17]. Studentswith good fluency not necessary have good flexibility and originality, but students with good originality usually have good fluency and flexibility. Overall the average percentage of students'scientific creativity at 43.81% shows that the scientific creativity of junior high school students Y Surakarta is still relatively low.

Scientific creativity in junior high school Y Surakarta certainly needs more attention so that students' scientific creativity can increase. Positive learning environment was related to creativity [18]. Two-thirds of ones' creativity ability is obtained through education, one-third of which comes from genetics [19]. That is, students' scientific creativity is something that can be changed through the learning process. Thus, in the learning process teachers should use a learning model that develops students' scientific creativity.Learning can be done by presenting natural phenomena, giving problems to be solved by students and providing opportunities for students to make products or design science products. Using supportive teaching strategies such as associating associative thoughts, encouraging conclusions based on evidence, reviewing and commenting on the opinions of other friends can develop students' scientific creativity [20].

4 Conclusion

Scientific creativity is a very important component in science learning.The result showed that the percentage of students' scientific creativity achievements are: fluency 56.17%, flexibility 44.64% and originality 30.63%. Based on the result, the average of students' scientific creativity was 43.81%. The scientific creativity of junior high school Y Surakarta students is still in the low category as indicated by the low fluency, flexibility and originality score. Therefore it is necessary to apply learning strategies that can develop students' scientific creativity through advancing the learning process.

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