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Exploration of Creative Thinking Skills of Students in Physics Learning

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Abstract. This study aims to determine the ability of creative thinking high school students in physics learning, know the form of assessment of creative thinking abilities. The study was conducted at SMAN 6 Yogyakrata. This type of research is a survey with a cross-sectional method that is a survey conducted once and at a time. The subjects were the principals, teachers of physics from SMAN 6 Yogyakrata and 30 grade XI students. observations, interviews, and questionnaires were used as data collection techniques. The data analysis method used was the quantitative-qualitative descriptive analysis. The results showed that the creative thinking ability of class XI MIA 1 students at SMAN 6 Yogyakarta can be said to be in the average and quite good category, although there are some students whose level of creative thinking ability is low. In addition, the form of assessment used by physics teachers has not been effective and accurate enough in assessing students 'creative thinking abilities. So it is recommended to use The Torrance Tests of Creative Thinking (TTCT) in physics learning because it has been proven to be accurate in assessing students' creative thinking abilities.

Keywords: Assessment, Creative Thinking, Physics.

INTRODUCTION

The development of science and technology is currently taking place very rapidly demanding every country to have human resources who have life skills in the 21st century, including in the sphere of learning. The skills in question are the ability to innovate, which includes critical thinking skills and problem solving, communication and collaboration, as well as creativity and innovation (Trilling & Fadel, 2009). Creative thinking is an essential soft skill for future and impacts on the development of innovation (Miller & Dumford, 2015). Creative thinking is often interpreted as a process. The ability to think creatively will give birth to creative generations who have the

potential to provide solutions to social problems and environmental issues (Yusnaeni, Corebima, A. D, Susilo, H., & Zubaidah, 2017). Creative thinking is generally considered a process of information to produce gathering new understanding, ideas or concepts (Srikoon et al., 2018). Creativity dimensions have been nurtured and enhanced as a result of the problem solving process involved in the experiential learning activities (Ayob et al., 2011). Thereby, in this article creative thinking skill means the ability to construct an idea into a unique pattern or structure. It puts the priority on the element of originality in the idea formed, related to the problems identified (Pada et al., 2016). From this it is realized that one of the important skills possessed by every student is creative thinking.

Torrance's first experiment found four aspects of creative thinking, namely fluency, flexibility, originality. and elaboration. (Kaufman & Sternberg, 2010). While Creativity is "the interaction among aptitude, process, and environment by which an individual or group produces a perceptible product that is both novel and useful as defined within a social context"(Plucker et al., 2004). Term of creativity refers to mental processes that lead to solutions, ideas, concepts, artistic expression, theories or products that are unique and novel (Setiawan, 2017). That's why teaching creativity is very important as a part in educational program and learning objects.

Physics learning will shape the character of students to think logically and systematically so that the ability to think creatively is needed by students. But, most of physics is taught in the form of giving examples of questions and exercises working on problems so students get stuck in the discussion of solving problems and very little understanding of the basic concepts in every physics material. (Angell et al., 2004). In addition to increasing the ability to think creatively it takes interest and a sense of comfort in learning. The good physics learning outcomes are influenced by scientific enjoyment and pleasure of students that provide good effects in learning physics (Kurniawan et al., 2019). The students who feel comfortable in learning physics use their imaginations and to be creative (Silvia & Beaty, 2012).

Based on the results of an initial interview with the physics teacher at SMAN 6 Yogyakarta, it is said that in physics learning, the ability to think creatively is not specifically designed for learning. But in the implementation of physics materials that are taught to direct students to improve all thinking abilities including creative thinking. Whereas on the 4C Skill competency map in accordance with the 21st Century Learning Students are expected to be able to produce, develop, and implement their ideas creatively both independently and in groups (Ariyana, Yoki et al., 2018).

The main key in seeing students' creative thinking abilities in learning lies in the form and type of tests used. Learning assessment has an essential role in generating students' creative thinking skills because in general, a person's ability will be seen if there is an assessment activity aim-ed at assessing that ability (Fardhila & Istiyono, 2019). Assessment should be well planned to measure knowledge and concepts, and high-level reasoning, and the ability to think creatively. Thus, through learning physics it is expected that students can develop their creative thinking abilities (Istiyono et al., 2014).

Based on the description above it is said that the ability to think creatively is very important in physics learning to improve the creative thinking abilities. All this time, there have been many studies on creative thinking but specifically observing implementation in schools, especially in physics subjects is still small. Therefore the researcher feels it is necessary to know (1) The students' creative thinking skills in physics learning at SMAN 6 Yogyakarta and (2) The form of assessment of creative thinking ability that is appropriate to be applied in physics learning at SMAN 6 Yogyakarta.

METHOD

Type of research is a survey using a *Cross* Sectional Survey. A cross-sectional survey collects information from a sample that has been drawn from a predetermined population. Furthermore, the information is collected at just one point in time, although the time it takes to collect all of the data may take anywhere from a day to a few weeks or more (Fraenkel & Wallen, 2009).

This research focuses on students' creative thinking abilities and forms of creative thinking abilities assessment. The intended creative thinking ability is the ability of students to come up with original ideas in solving a problem seen from *fluency thinking*, *flexible thinking*, *original thinking*, and *elaborative thinking*. Meanwhile the form of assessment of creative thinking abilities is the type and form of assessment instruments that are appropriate and effective used in assessing creative thinking abilities.

The subjects of this survey were students of class XI of SMAN 6 Yogyakarta so that it could be done only once. The sampling technique used was *Convenience Sampling*. *Convenience Sampling* including people who are available, volunteer, or can be easily recruited in the sample. This sampling technique is used, it is especially important that researchers describe the characteristics of the people participating in their research studies (Johnson & Christensen, 2017.). So that the sample used was class XI MIA 1 students totaling 30 people consisting of 11 men and 19 women.

Data collection instruments used in this study were in the form of observations, interviews, and questionnaires. The data obtained in the form of quantitative data from classroom observations and questionnaires filled out by students and qualitative data obtained from interviews with physics teachers. After the answers to the survey questions have been recorded, there remains the final task of summarizing the responses in order to draw some conclusions from the results. The total size of the sample should be reported, along with the overall percentage of returns. The percentage of the total sample responding for each item should then be reported (Fraenkel & Wallen, 2009).

Data analysis in this study was obtained from data in the field which was then analyzed in quantitative form in the form of descriptive statistical analysis of the results of student questionnaires and observations. And qualitative analysis is the result of the interview and the dominance of the learning program design from the physics teacher.

RESULTS AND DISCUSSION

Results

The subjects in the survey were 30 XI MIA 1 students of SMAN 6 Yogyakarta. Then the researchers observed the physics learning activities that were taking place at the time. From the results of observations made obtained: 1) When the teacher gives questions to students, the response given by students is quite passive. They lack the initiative to work on the problem directly. But when the teacher gives a gift in the form of additional value, then they rush to each other competent to do it. 2) Most female students who dare to work on the board, and only two male students who dare to write their answers on the board. 3) Of the several questions that have been done, they do it exactly with the steps given by the teacher. 4) When learning takes place, there are some students who don't work at all, they just wait for answers from friends who do it in front. Next students were given a questionnaire about the ability to think creatively in learning physics. The results of the questionnaire obtained by students are then grouped to find out the profile of students' overall creative thinking abilities. The data obtained were grouped into three categories: high, medium and low. The comparison can be seen in table 1 below.

Tabel 1. Recapitulation of the Percentage of Students in each Category of Creative Thinking Ability							
Interval	Frequency	Percentage	Category				
Score \geq 36	13	43.30%	High				
$24 \leq \text{Score} < 36$	14	46.70%	Medium				
Score < 24	3	10.00%	Low				
Overall	30	100%					

Tabel 2.	Average	Percentages	of Each	Aspect	of Students'	Creative	Thinking	Abilities

No	Aspects of Creative Thinking Ability	Mean	
1	Fluency	80	
2	Flexible	93	
3	Original	84	
4	Elaborative	84	

Based on table 1 it can be seen that students who have a high level of creativity are 13 people with a percentage of 43.3%, a moderate level of creativity are 14 people with a percentage of each that is 46.7% while the rest are at a low level of 3 people with a percentage of 10%. Of the 30 students the highest score was 48 while the lowest score was 19.

Subsequent creative thinking skills are reviewed based on the four aspects of creative thinking ability which are categorized into four Thinking, *fluency thinking*, *flexible thinking*, original thinking, and elaborative thinking.

Based on table 2, it was found that for the aspect of high creative thinking ability that is flexible thinking with an average value of 93 and the lowest is the ability to think fluently with an average of only 80. For the ability to think originally and the ability to think elaboratively has an average value the same average is 84.

Based on the interviews with the physics teacher at SMAN 6 Yogyakrata obtained information about the form of the assessment of the ability to creative think is the form of assessment merged into one type of assessment. The teacher stated that so far the assessment of students' creative thinking abilities had not been specifically done. All 4C learning skill assessment, such as *Critical Thinking* and *Problem Solving, Creativity, Communication Skills,* and *Collaboratively Ability to Work* are merged into one type of assessment.

The teacher revealed that he did not have questions that measured the ability to think creatively and accurately about teacher problems using test questions, because he considered more able to see student creativity. In addition, this teacher also stated that this is about the ability to think creatively by the participants. Number of participants released into one of the various Value types. As in the learning outcomes test, project assessment, practicum assessment and product assessment.

Discussion

Based on the results obtained, the following descriptive analysis for each of the creative thinking abilities along with the assessment form used.

1. Fluency Thinking Ability

According to Torrance (Kaufman & Sternberg, 2010) *fluency* is the ability to produce a number of ideas, the characteristics of fluency include: (a) Come up with lots of ideas, lots of answers, lots of problem solving, lots of questions smoothly; (b) Give many ways or suggestions for doing various things; (c) Always think of more than one answer

Based on the data in the table that the average ability to think smoothly is 80. When students are given a physics problem they do not immediately work on it. They are more likely to expect answers from their peers who are considered smart in the field of physics. This is because they have never done the same problem before so they have no knowledge in working on the problem. But when the teacher tells them to look at a book or note of a new lesson then they solve the problem by discussing it with other friends. Nevertheless this is something that is quite well applied in studying physics material that is quite complex and complicated. By discussing they can express their ideas to solve the problem easily and they understand. Creative

thinking teaching indeed could stimulate students' creative thinking ability to think of many innovative ideas (Lin & Wu, 2016) .Therefore, it is not surprising that the ability to think fluently is the lowest ability possessed by students.

2. Flexible Thinking Ability

According to (Prasetiyo et al, 2014: 40), flexible thinking is when someone is able to think of more than one idea in solving a problem. From table 2, the results show that students have the ability to think Flexible with an average of 93. Seeing the average is based on the analysis of the results of answers in working on physics problems that most of the XI MIA 1 students of SMA Negeri 6 Yogyakarta most of which can produce ideas or answers that can answer questions. They can find the core problems that exist in the problem and know the steps - steps in providing the right solution. The use of practical examples in the implementation of the use of the knowledge being learned can enhance student creativity (Setiawan, et al., 2020). So it's no wonder they have the highest level of flexible thinking among the other creative thinking abilities.

3. Original Thinking Ability

Torrance suggests that Originality, which has new ideas to solve problems (Kaufman & Sternberg, 2010). Original thinking is the ability to express ideas or solve problems in ways that have never been thought of by others. According to (Yarbrough, 2016) originality is usually determined statistically. The more extensive the knowledge, the more likely it is to bring up new ideas, so that they can affect one's original thinking ability.

Based on table 2, the results of data analysis found that the average value for the original thinking ability was 84. From the average it was shown that the students' original thinking ability was good enough. However, when analyzed in more depth the average value identified that students were still not sensitive to the characteristics of the material available in physics so that when they were given different problems, they had to look at the book again. It is noticeable that the internals actively change their environments to take control of the events and to alter unsuitable positions (Flor et al., 2013). Basically, sensitivity to the material or questions that have been given is one of the factors needed in realizing the ability to think creatively so that it can bring up new ideas or ideas that have never been thought of by others.

4. Elaborative Thinking Ability

Elaboration ability is the ability to elaborate is one's ability to describe a simple thing to a broader definition (Prasetiyo et al, 2014). Based on table 2 the results of data processing analysis that the ability to think an average value of 84. From the percentage seen that the elaborative thinking ability of students is good enough. But it's still not good enough to solve problems correctly. In spite of this, there was a difference in elaborative thinking ability, where the male students were better in elaborating ability than the female students (Piaw, 2014).

Previously, they did find it difficult to explain the steps to solve the problem and were confused about where to start then the students paid attention to the details of the problem solving steps taught by their teacher. After that it is seen when they are given a physics problem and then solve it starting from the data shown in the problem, the questions in the problem and answering questions using data that is known each step by step. Student creativity in solving physics problems also supported by a learning environment that fosters creativity among students themselves (Wahyudi et al., 2019).

5. Form of Assessment of Creative Thinking Ability

Based on observations and questionnaires from the overall survey results obtained by researchers, shows the ability of students to think creatively in the medium category. And also the results of interviews with the physics teacher that there is no specific form of assessment in observing and assessing students' creative thinking abilities. So far, the forms of assessment used are tests, and nontest instruments such as product assessment and practicum assessment, and student portfolios. All of the assessment instruments are combined in evaluating the half of student learning outcomes during the physics learning process. Whereas assessing the ability to think creatively, it is important to assess the process, rather than merely emphasizing cognitive test results (Lin & Wu, 2016). Thus, the form of assessment used by physics teachers at SMAN 6 Yogakarta is not effective and accurate enough to be used in generalizing students' creative thinking skills in different schools.

Therefore the results of this survey serve as a reference or need assessment in making the right type of assessment in measuring students' creative thinking abilities. Plucker, Beghetto, and Dow recommend that all examinations of creativity clearly define the authors' conception of creativity as used in that work. As a result, Creativity is the interaction among aptitude, process, and environment by which an individual or group produces a perceptible product that is both novel and useful as defined within a social context (Plucker et al., 2004). As the cognitive functions of creativity: thinking, different dreaming. having perspectives, flexibility, fluency, originality and enrichment affect deeply the students' capacity of learning and problem solving, also their skills' development (Ersoy & Başer, 2014).

One type of Assessment of creativity that is very channelized and most often used is the Torrance Test of Creative Thinking (TTCT) developed by Torrance in 1982. The TTCT test is the most well known creative thinking test. It has been translated and used in more than 25 different languages (Piawa, 2010). Torrance then developed a scale that comprises the four properties of Gilford on creativity and made it useful on education grounds. The Torrance Tests of Creative Thinking (TTCT) by E.Paul Torrance has three components: (1) Thinking Creatively with Pictures measures creative thinking using three picture-based exercises to assess five mental characteristics: fluency, originality, elaboration, abstractness of titles, and resistance to closure. (2) The Figural TTCT contains abstract pictures and the examinee is requested to state what the image might be. (3) The Verbal TTCT: contains presents the examinee with a situation and gives the examinee the opportunity to ask questions, to improve products, and to "just suppose (Bacanlı et al., 2011). Yarbrough has successfully proven the Torrance Tests of Creative Thinking (TTCT) in assessing Across Cultures in Turkish elementary and secondary students. 35 professionals were trained in a full workshop to learn to score the verbal TTCT. The results of item level analysis for fluency and flexibility data from the 35 trainees reveal new information about translation, training, and scoring (Yarbrough, 2016). The use of TTCT in physics learning will be effective and accurate to measure creative thinking skills that focus on observing their behavior in solving physics problems.

CONCLUSION AND SUGGESTION

The ability to think creatively of class XI MIA 1 students in SMA Negeri 6 Yogyakarta can be said to be in the average category and is quite good, although there are some students whose level of creative thinking ability is low but that does not mean students are not creative because creativity can be obtained from other activities. Characteristics of the highest creative abilities on average are flexible thinking skills and the lowest average percentage are smooth thinking skills. Besides the form of assessment that is owned by the teacher in assessing students' creative thinking abilities is spread out in sharing types of assessment such as test instruments namely learning outcomes tests and nontest instruments such as product assessment and practicum assessment. The teacher does not have special assessment instruments in assessing students' creative thinking abilities. But the teacher prefers non-test instruments, because they are considered more able to see student creativity. As a suggestion, physics teachers need accurate assessment models needed to assess students' creative thinking abilities more comprehensively. The teacher can use The Torrance Tests of Creative Thinking (TTCT) in physics learning because it has been proven to be accurate in assessing students' creative thinking abilities.

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