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STEM Education in Integrative Thematic Learning to Improve Students' Creative Thinking Abilities in Elementary School

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Abstract. This study was aim to improve students' creative thinking skills in integrative thematic learning in elementary schools using STEM education. This research used a quasi experimental design in the form of non-equivalent pretest-posttest control group design, carried out on fourth grade students of elementary school. The results obtained showed that students' creative thinking abilities increased significantly, the ability was shown by students in answering questions given to them after following the learning done by the teacher using the STEM education approach. For this reason, through the use of STEM education in thematic learning, it is possible for students to get used to conducting comprehensive analysis of problems and solutions. STEM education is a learning approach that can be used by teachers in the learning process in order to familiarize students in conducting analysis and synthesis, so that an idea emerges that is able to develop students' competencies and creative thinking abilities. Thus in addition to the scientific approach as an approach used in integrative thematic learning in elementary schools, the teacher can innovate in developing strategies and learning approaches using STEM education as the best solution in an effort to improve the creative thinking skills of elementary school students, in the context of learning in the century 21st.

1. Introduction

Integrative thematic learning in elementary schools is a consequence of the enactment of the 2013 curriculum [1] at the education unit level. The form of thematic learning is packaged in an integrated manner that covers the whole field of study [2], so that initially separated into one whole unit in a particular theme [3]. And then each theme can be divided into several sub-themes.

Integrative thematic learning is intended so that the learning followed by students is more meaningful and intact. The meaningfulness of learning for students can be achieved because it learns a concept holistically and is no longer separated from one subject to another. Such learning can psychologically provide a meaningful experience for students, because in these learning students will understand important concepts that will be learned through direct

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experience and relate them to other concepts that they previously understood [4].

In addition, the role of integrative thematic learning is very important for students in following the learning process. This is because integrative thematic learning can increase attention, learning activities, and students' understanding of the material being studied, because learning is more student- centered, provides students with direct experience, the separation of subjects is not very clear. For that, in presenting concepts from various subjects can be flexible in a learning process, so that learning outcomes can develop according to the interests and needs of students [5].

With the existence of integrative thematic learning in the 2013 curriculum, the ability to think holistically in elementary school students can be directed to the development of creative thinking skills [6]. And creative thinking according to Weisberg [7] refers to the process of producing a product which is a new (innovative) work that is obtained from an activity that is directed according to the purpose by involving an element of intent. So that it can be interpreted that creative thinking is the ability to create new things [8].

So that the results of the thoughts raised from creative thinking are actually something new for the person concerned and is something different from what he usually does [9]. Thus it can be said that the ability to think creatively is a thinking ability that starts from a sensitivity to the situation at hand, wherein the situation identifies a problem that must be resolved.

This is the highlight of various parties, that the ability to think creatively in elementary school students has not shown encouraging results, this weakness is seen when faced globally, that the scores of international student assessment programs (PISA 2015) Indonesia are still low, from 72 participating countries PISA, Indonesia is ranked 63rd. The same thing when viewed from TIMSS 2015 results, Indonesia is ranked 45th out of 48 countries for the science sector, while for mathematics it is ranked 45th out of 50 countries. In general, Indonesian students are weak in all aspects of content and cognitive, both for mathematics and science [10].

The low level of PISA and TIMSS scores of Indonesian children is inseparable from the weak ability to think creatively, because working on high and advanced categories requires the ability to think creatively in completing them [11]. The low ability of creative thinking for students is caused by various factors, one of which is the way teachers carry out learning in class [12], which never trains students to analyze an issue, also because the learning approach used by the teacher is still teacher- centered.

The role of the teacher in the class in the 21st century must shift from expert to facilitator and the focus of the teaching changes from knowing to being able to use and apply information in a relevant way [13]. For that the teacher needs to use a learning approach that can train students' creative thinking skills [14]. One learning approach that can be used to practice creative thinking skills is the STEM learning approach [13].

STEM education provides new hope for the world of education, especially in the learning process. Various research results have proven that the application of STEM education in learning can encourage students to design, develop and utilize technology, sharpen cognitive, manipulative and affective, and apply knowledge [15]. And then STEM education-based learning can train students to increase knowledge, apply knowledge to solve problems and encourage students to produce something new [16].

The results of the study conducted by Chittum et all, [17] found that students who attended STEM learning were more motivated in learning and thus improved their learning outcomes. Students can think more broadly [18]. And it can also increase the ability of students to think critically [19].

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In line with the thoughts outlined above, the effort to improve students' creative thinking skills in thematic learning in primary schools is to make an innovation in learning that involves various approaches, including STEM education.

2. Method

This study uses a quasi experimental design in the form of a non-equivalent pre-post control group design. This design is used to compare the increase in students' creative thinking skills after STEM education learning is carried out between the experimental class and the control class. The sample in this study were 43 students of class IV Bagura 2 Elementary School of Kendari City, which were divided into two groups, 21 people for the experimental group and 22 people for the control class.

Learning in the experimental class is done by applying STEM-based learning, while in the control class it is done with ordinary learning in accordance with thematic learning guidelines. The research

data was obtained from the test results in the form of questions given to students, both in the experimental class and the control class.

Data analysis was performed using descriptive and quantitative statistical analysis such as the following:

2.1. Gain Test

Used to determine the increase between the pre-test and post-test or gain. The magnitude of the increase is calculated by the normalized gain formula [20], namely:

$$g = \frac{posttest\ score - pretest\ score}{maximum\ possible\ score - pretest\ score}$$

The results of the calculation of the Gain above are then interpreted using the adapted categories as follows: high category if (<g>)> 0.70; medium category if 0.70> (<g>)> 0.30; low category if (<g>)
<0.30 [21].

2.2. Statistic test

Used to determine the increase between the pre-test and post-test by using a paired sample t-test statistical test, while to find out the difference in the average score between the experimental classes using the STEM education approach and the control class using a conventional approach statistical tests were used Independent Sample t-Test. The basis of decision making is based on probability values, where if sig> 0.05, then it is accepted, but if sig <0.05 then it is rejected.

3. Result and Discussion

Research on improving creative thinking skills in thematic learning through STEM education based learning can be described in the experimental group and in the control group as follows:

The average value of the gain test results in the experimental class and control class can be seen in Table 1 below:

Table 1. Average gain values for each group

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Experiment Class			Control Class		
Pres-Test	Post-Test	gain	Pres-Test	Post-Test	gain
41,90	85,48	0,75	39,77	65,45	0,43

Based on the average gain value in Table 1 above, the results of the gain in the experimental class (0.75) are higher than the gain in the control class (0.43), and based on these data, the mean gain of the experimental group is high, while the average the gain of the control group is in the medium category

In addition to the results of the research as in table 1 above, this study also produces an increase in the calculation of each indicator of creative thinking as described in Figure 1.

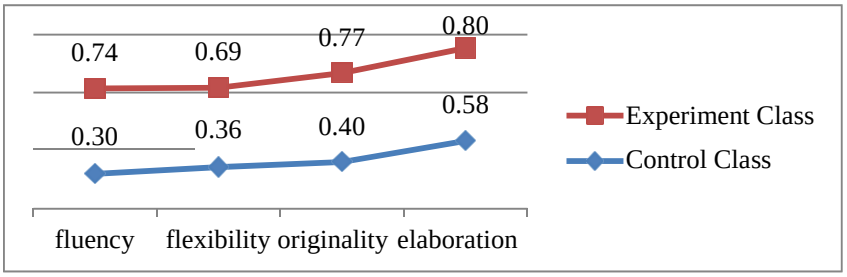

Figure 1. Graph Indicators Gain Value Calculation Creative Thinking

From the four indicators of creative thinking in the experimental group, the elaboration indicator has a higher increase (0.80), followed by the originality indicator (0.77), then the fluency indicator (0.74) and the flexibility indicator (0.69). While the indicator of creative thinking in the control group, also shows the same phenomenon, namely the elaboration indicator has a higher increase (0.58), followed by the originality indicator (0.40), then indicators of flexibility (0.36) and fluency (0.30).

While the results of statistical calculations to test hypotheses can be described as in Table 2 below.

Table 2. Summary of statistical test results for creative thinking skills

	Test Normalitas	Test Homogenitas	t-test
Experiment Class Control Class	p = 0.333 p = 0.111	p = 0.001	p = 0.000 t' = 8.450

Based on the results of the statistical test in Table 2, it shows that the sig value is 0,000 <0,05, then Ho is rejected, so that learning is done based on STEM education, there are significant differences with ordinary learning. And on average the gain value of the experimental group is 0.75 higher than the average gain value of the control group which is 0.43.

STEM education-based learning carried out in integrative thematic learning in class IV of Bagura 2 Elementary School in Kendari City, refers to four indicators namely fluency, flexibility, originality, and elaboration [22]. The four indicators are an integral component of learning that prioritizes creative thinking [23].

The results of the study found a difference between the two classes. This difference is caused by the effect of the treatment given to the experimental class, which is STEM education-

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based learning compared to the control group given by ordinary learning. That learning based on STEM education can improve students' abilities in creative thinking skills compared to ordinary learning.

This data is obtained that before STEM education-based learning is carried out, the average ability of students' creative initial thinking is categorized as low. The low ability of students' creative thinking is caused by each student not accustomed to generating many ideas for various questions and not yet accustomed to carrying out the steps in detail. But after learning STEM-based education, the students' creative thinking ability has increased, which is categorized as high and very high.

The results of the increase in calculation of each indicator of creative thinking in Figure 1 shows that on the average of the four indicators, the gain of each indicator from the experimental group is greater than the gain of each indicator in the control group. The mean gain of each indicator of creative thinking in the experimental group shows a high category, while the average gain of each indicator of creative thinking in the control group shows a moderate category.

On average the elaboration abilities of students are high compared to other indicators. This reflects that the student's ability to explain in detail, coherently, and coherently to a particular procedure, answer, or situation as a solution to the correct problem that he gave well by students.

Elaboration skills are skills in developing, adding, enriching an idea, or detailing details, and expanding an idea [24]. The instruments that explore elaboration skills in students are in question number two, which presents problems and then students are asked to explain about refraction of light, then in question number three presents images and then students are asked to describe the formation of shadows on a flat mirror, in question number five students asked to explain the formation of shadows and the properties of shadows on a convex lens. Based on the results of the analysis of the students' answers, it shows that the questions number two, three, and four which describe the elaboration indicator reach the very creative category.

Furthermore, the ability to think of originality is the ability to give unusual answers, which are other than others, which are rarely given by most people [24]. It's just that in this question there are several students who answer with one answer that is commonly answered by other students and do not provide varied answers. The ability to think originality is greatly influenced by the breadth of one's knowledge and the more likely it is to come up with new ideas that are different or unusual for most people to use [25]. So it can be concluded that students' ability to improve originality thinking is quite good.

Then thinking flexibility is the ability to change forms, develop information, or change views [26]. Behavior of students who demonstrate the ability to think flexibility is that students can provide a variety of unusual uses of an object, provide various interpretations of an image, story or problem, apply a concept or principle in different ways, give consideration to different situations with given by other people, thinking of various ways to solve problems, classifying things according to division (different categories), and being able to change the direction of thinking [27]. In the results of this study it was found that the ability to think flexibility of students reached the medium category. It was found that some (65%) students were able to see problems from different perspectives and were able to change the way they approach or think when solving a problem. In addition, they have been able to gather information from the problems presented even though sometimes they have difficulty understanding the purpose of the questions given.

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Ability to think fluency is the ability to generate many ideas [25]. The behavior of students who demonstrate fluency thinking skills is that students ask many questions, answer with a number of answers, smoothly express ideas, and quickly see errors or shortcomings in an object or situation [27]. Based on the results of student creativity tests it was found that aspects of fluency thinking ability had reached the moderate category. It can be seen that the ideas issued by students are quite a lot like ideas for finding various forms of alternative energy, ideas for solving problems related to energy use. To find various forms of energy, students use the media that have been provided, namely books, newspapers, pictures and videos. In addition, students have also been able to solve problems in various ways or find different answers.

In this study STEM education-based learning that has been carried out on integrative thematic learning produced several findings, namely in table 1 above shows the gain of the group given STEM education-based learning is higher than the group that only does ordinary learning. This is possible because to produce something creative as a result of creative thinking skills requires a process that produces something new with ideas that are also new, original, in order to solve existing problems well and in stages [28]; [29].

The same thing from the results of the average gain increase for each indicator on students' creative thinking abilities, seen in Figure 1 above shows that the four indicators, namely fluency, flexibility, originality, and elaboration show greater gain in the group given STEM education-based learning compared to groups that only do ordinary learning.

Furthermore, in Figure 1, it also shows that in the group given learning using STEM education, the ability of students' creative thinking with indicators, namely fluency, flexibility, originality, and elaboration, both experienced an increase in the high category. On the contrary, in the group given ordinary learning, it is still in the moderate category. Because according to Vale and Barbosa, that if a student is not able to think of a solution in learning even does not understand the problem given, then the student will not be able to create a solution to the problem, even a lot of how to solve the problem must be guided. Even to get creative thinking, high curiosity is needed by the process of exploration and observation, as well as imagination and high thought originality [30].

In table 2 shows that after the Independent Sample t-Test statistical test, the results obtained that learning is done based on STEM education there are significant differences with ordinary learning. So that the three test results that have been carried out as above, show that learning based on STEM education can improve students' creative thinking skills in thematic learning in elementary schools. Increased ability of creative thinking of students is caused by their ability to answer questions that require variations in answers with various solutions.

This is in line with the results of Pertiwi's research, that the learning activities presented in STEM begin with giving a problem or phenomenon to be able to train students 'creative thinking skills and the results can improve students' creative thinking skills [14]. This is similar to the research of Subramaniam et al (2012) which states that STEM learning can develop when it is associated with the environment, so that students experience learning in everyday life [31].

The same thing done by Parwati in the context of the environment shows that STEM learning can build creativity and environmental literacy, which is very necessary to deal with the 21st century [32]. Because in general, the application of STEM in learning can encourage students to design, develop and use technology, sharpen cognitive, manipulative and affective, and apply knowledge [33]. Therefore, the application of STEM is suitable for use in science learning, because STEM-based learning can train students to apply their knowledge to create designs as a form of solving problems related to the environment by utilizing technology [16].

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STEM has been widely applied in learning [16]. This situation is shown from the results of research that reveal that the application of STEM can improve students' academic and non-academic achievements [34], [35].

Clegg and Brich stated that the ability to think creatively for individuals is no longer a complement but has become a major factor that every individual must have to survive in the midst of increasingly fierce global competition [31]. Likewise Permanasari states that STEM (Science, technology, engineering and mathematics) education is currently an alternative learning science that can build generations that are able to face the 21st century which is full of challenges [16].

4. Conclusion

The STEM education approach used by teachers in the process of thematic learning in the fourth grade of elementary school can improve students' creative thinking skills, this is indicated by the results of student answers to the test questions given. The average gain of students in the experimental class (0.73) was higher than the control class (0.42). The students' thinking skills both logical, analytical and problem solving can develop after participating in classroom learning guided by the STEM education approach. Thus the STEM education approach can be a good choice for teachers in conducting thematic learning in an effort to improve students' creative thinking skills, so they can prepare students in the framework of 21st century learning. For this reason, it is hoped that the STEM education approach can be continuously disseminated to primary school teachers through training, seminars and conferences. More effective activities in order to develop teacher skills using STEM education as an approach in conducting the learning process in the classroom are in the Teacher Working Group (KKG) forum, because this forum is a forum for professional development for elementary school teachers.

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