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IMPROVING STUDENTS' CREATIVE THINKING SKILLS USING SCIENTIFIC BASED ELECTRONIC SCIENCE MODULE

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The Covid-19 pandemic has changed various aspects of human life today, especially in the world of education which requires all elements of education to keep classes active even though it is done online. Distance learning requires students to be able to learn independently. The purpose of this study was to analyze the improvement of students' creative thinking skills on the material of vibration and waves using a scientific-based science module. The method used in this research is pre-experimental with one group pretest-posttest design. A total of 30 students of class VIII SMPN 15 Surakarta, were randomly selected as participants in this study. To measure the improvement of students' creative thinking skills, multiple choice tests have been developed based on indicators of creative thinking abilities. After analyzing the data, the N-gain value on the fluency indicator is 0.39, the flexibility indicator is 0.58, the originality indicator is 0.59 and the elaboration indicator is 0.45. This number means that creative thinking is in the moderate category. Further analysis shows that, by using scientific-based electronic modules on vibration and wave materials, students' creative thinking skills can increase, especially on the originality indicator.

Introduction

The development of information, technology, and digitalization in the era of the 4th industrial revolution has created a new paradigm in education otherwise known as 21st century learning. In the new era of education, teachers should be able to facilitate students to think critically and creatively and have good communication and cooperation skills (Griffin, Care, &McGaw, 2012; Shidiq &Yamtinah, 2019; Trilling &Fadel, 2009)

The demand for a change in human mindset in the 21st century according to Trilling and Hood (1999) is to prepare to be able to live and work in the period of knowledge (knowledge age) especially in the field of education. The quality of life of the nation can be improved if supported oleh strong education system (Trilling,2009). In the 21st century, high-level thinking skills have strategic values to apply. Educators and students are required to have the ability tolearn to teach the21st century. The 21st century skills in question include critical thinking, collaborative skills, communication, and creative thinking. All countries of the poor, developing, and advanced categories need the ability to develop creative thinking (Freudenberg, 2011)

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education almost that has never been simultaneously spoken before for all elements of education, namelystudents, teachers and parents. (Sun et al., 2020). Considering the pandemic, time, location and distance are big problems today (Kusuma &Hamidah, 2020). This challenges all elements and levels of education to keep the classroom active even if the school has been closed. The COVID-19 pandemic suddenly required an educational element to maintain online learning. The current condition is urgent to innovate and adapt related to the use of available technologies to support the learning process (Ahmed et al., 2020).

The solution in solving the problem is to use an electronic IPA module. Modules are learning tools that contain materials, methods of limitations and ways of evaluating that are designed systematically and interestingly to achieve the expected competencies according to the level of complexity. Modules are prepared with the aim of helping students learn something, make it easier for educators to teach something and to make learning activities more interesting (Depdiknas, 2008). The nature of the module that selfinstructional will help students in the covid-19 pandemic as it is today so that students are able to learn independently and not rely on other parties (Mustaji, 2008).

The IPA module offered as a solution is a scientific-basedelectronic IPAModule. Based on Hosnan (2014:34) scientific approach is a learning process designed in such a way that learners actively construct concepts, laws or principles through the stages of observing (to identify or find problems), formulating problems, proposing or formulating hypotheses, collecting data with various techniques, analyzing data, drawing conclusions and communicating concepts, laws or principles found.

The focus of this research is to improve one of the skills that students need in the 21st century, namely creative thinking skills. According to Kampylis &Berki (2014), creative thinking is defined as a thought process that allows students to apply their imagination to generate ideas, formulate questions and hypotheses, experiment with alternatives, and evaluate ideas, processes, and end products. Creative thinking is essentially related to the discovery of something, and concerns things that produce something new by using something that already exists (Daryanto, 2009).

Creative thinking has a lot of clumps. Some experts see it as a process that goes through stages. Other experts see creative thinking in terms of creative products and creative people. Some who see it as a process are Isaksen and Treffinger (Treffinger &Isaksen, 2005); and Torrance (Phillips &Torrance, 1976; Torrance, 1968, 1973; Torrance &Aliotti, 1969; Torrance &Hansen, 1965). They are experts in education and creativity (Freeman, 1999).

Many experts and psychologists prefer to call creative thinking skills "divergent thinking", "productive thinking", or "imagination". Some scientists prefer to use the term "creative" only to refer to rare, special, and substantive capacities (Torrance, 1968). Previous research conducted by (Kamalasari, 2019) showed that online modules can improve students' creative thinking skills. In addition, other research from (Fisher, 2019) showed the results that the E-learning Based Scientific Approach is able to improve the creative thinking skills of grade VIII students.

Specifically the purpose of this study is to analyze the improvement of students' creative thinking skills on calorific material and their displacement using scientific-based electronic science modules. This research is expected to contribute to the novelty of teacher learning models to improve students' creative thinking skills on calorific material and its displacement.

Method

The method used in this study is a pre-experimental method with the design of one group pretest-posttest only design (Fraenkel, 2012). The sample selection technique used in this study is random sampling so that a sample of 30 junior high school students in grade VIII is obtained. The research was conducted at SMPN 15 Surakarta.

The data collection instrument used is a multiple choice test of 10 items. Before the test question is used for research, the test questions that have been prepared are tested first. The quality of the measuring instrument of the learning outcomes of the knowledge aspect, determined by several factors, among others: (1) reliability test, (2) difficulty level, and (3) test differentiator. The indicators of creative thinking skills used are adapted from Guilford (Guilford, 1988) which includes;

a. Current thinking (Fluency); ability to generate multiple ideas, answers, problem solving, or questions.
b. Flexible thinking (Flexibility); the ability to generate ideas from information that has been obtained.
c. Original thinking (originality); the ability to generate new and different ideas or ideas from the previous ones.
d. Thinking elaboration (elaboration); the ability to develop and add ideas in detail so that they become more interesting.

Data analysis techniques are done by tabulating the data that has been obtained, then calculating the percentage of score of each component of the question consisting of 10 questions related to creative thinking skills that have been given to 32 grade VII students, then calculate the percentage of score of each aspect using the following formula:

$$Ps=\frac{Ni}{N}$$

Ps is the percentage score; Ni is the number of scores obtained, and N is the number of maximum scores for each aspect. The results of the percentage scores of each component are indicated by the criteria according to Shriki (2013). These categories are shown in Table 1.

Table 1. Criteria for average values in creative thinking profile scores

Persentase	Kategori
< 55%	Rendah
≤ 55% - <75%	Sedang
≥75%	Tinggi

The analysis used to determine the effectiveness or increase (gain) of students' creative thinking skills whose learning process applies scientific-based electronic science modules is the Gain score. Gain score is also called an increase or difference in score which shows the difference between pretest and posttest scores in one sample group. According to Meltzer, D.E. (2002) Gain scores can be obtained using the following formula:

$$N\text{-gain}=\frac{Tpost-Tpre}{Tmaks-Tpre}$$

Tpost is the average posttest score; Tpre is the mean score of the pretest, and Tmax is the maximum ideal score. The N-gain score obtained from the above formula can be categorized using the gain score interpretation table according to Table 2.

Table2. N-gain category

Nilai <g>	Kategori
(g) ≥ 0,7	Tinggi
0,3 < (g) ≤ 0,7	Sedang
(g) ≤ 0,3	Rendah

Result and Discussion

The purpose of this study was to analyze the improvement of students' creative thinking skills on vibration and wave material using the application of scientific-based electronic science modules. Creative thinking skills used in this study refer to Guilford (Guilford, 1988). This study adopted Guilford's creative thinking skills because in addition to being in line with the research objectives, Guilford's research framework also has several advantages including having a complete picture of creative thinking, namely operations, content, and production (Anoiko, 2011) and distinguishing convergent and divergent thinking processes (Anoiko, 2011; Costa, 1991).

Science learning using scientific-based electronic science modules is learning that is carried out based on discoveries obtained from a series of investigation processes. In the implementation process, students learn independently because they adjust health protocols during the COVID-19 pandemic which requires students to study from home. In this learning process, the teacher acts as a monitor, facilitator, and evaluator in student involvement in learning (Barthlow and Watson, 2011). The teacher as a learning facilitator provides assistance to students to find facts and concepts. Concepts are not given explicitly but the teacher encourages and encourages students to be able to make conclusions and make predictions. The next measurement was carried out after the experimental group was given learning treatment using a scientific-based electronic science module and the control group by not using a scientific-based electronic science module for six meetings conducted online on the same teaching material. The IPA module used can be seen in Figure 1.

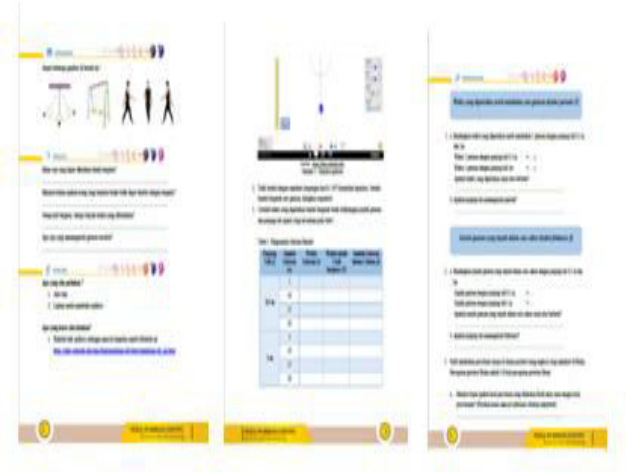

Figure 1. IPA Module Content Display

Data on students' creative thinking skills were obtained by giving 10 multiple choice questions representing 4 aspects of the indicators of creative thinking ability. Examples of critical thinking instruments are presented in Table 3. The difference in scores obtained by students before and after learning using scientific-based electronic modules is presented in Table 4.

Table 3. Instruments about creative thinking

Basic Aspect of Creative Thinking	Indicator	Question
Flexibility of Thinking (*Flexibility*)	Seeing a problem from a different point of view on the concept of waves	The rumbling sound produced by thunder, the sound of passing vehicles in front of the house can vibrate the windows of the house. Why does it happen? A. The location of the house is too close to the highway B. The frequency of the sound wave of thunder is the same as the frequency of the vibration of the window glass atom C. The sound of thunder is reflected by the atoms of the window glass D. Improper installation of home window glass

Table4. Descriptive statistics of students' creative thinking skills score

Descriptive statistics	Pretest				Posttest			
	Aspect				Aspect			
	A	B	C	D	A	B	C	D
Total Score	29	29	26	26	53	47	46	55
Maximum Score	90	60	60	90	90	60	60	90
Percentage	32,22	48,33	43,33	28,89	58,89	78,33	76,67	61,11
Category	Low	Low	Low	Low	Medium	High	High	Medium

Table 5 shows the scores on each aspect of creative thinking obtained by students before and after using the scientific-based electronic science module. Before the scientific-based electronic science module was applied, students' creative thinking skills were in the low category, but after the scientific-based electronic science module was applied, the results showed that students' creative thinking skills were in the medium and high categories. The increase in students' creative thinking skills is due to the application of learning models that provide opportunities for students to think. The scientific-based electronic science module applies five stages of learning consisting of observing, asking, exploring, analyzing, and communicating.

In learning using scientific-based electronic science modules, students are also facilitated in implementing their knowledge through problems, learning to communicate, and most importantly being able to carry out a reflection process to improve their process skills. Therefore, the scientific-based electronic science module is considered capable of accommodating students in developing creative thinking skills. This can be seen in Figure 2.

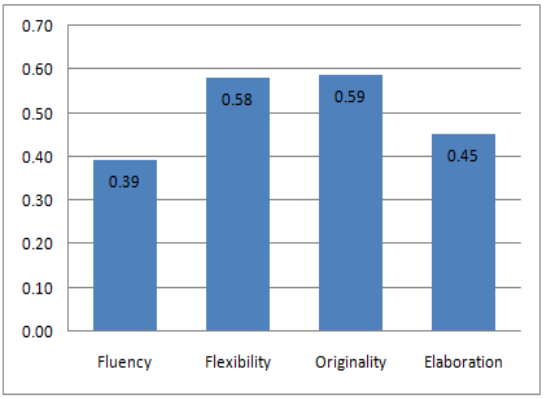

Figure 2. N-gain of students' creative thinking skills

The values shown on the chart indicate that the N-gain earned for each aspect is in the medium category. This means that through the defense of using electronic science modules based on scientific creative thinking skills students can be developed adequately.

Fluency aspect has an N-gain value of 0.39. The fluency aspect allows us to assess students' ability to generate many ideas, answers, problem solving, or questions. However, this ability can still be honed because the POGIL model allows students to explore and reflect on activities. Both activities can spur students to create new solutions.

Aspects of flexibility will be observed when students are able to see a problem from more than one point of view, and when they are able to connect other disciplines to solve the problem at hand. This is because scientifically based electronic SCIENCE modules provide

students with problems, and can be solved in more ways than one.

The originality aspect refers to how students present innovative problem solving. The innovation of student problem solving can be a modification of anything that exists or the presentation of something entirely new. Based on the N-gain value, this aspect has the highestvalue.

The elaboration aspect is an aspect of creative thinking that demands students to enrich and explain in more detail the proposed solutions. Scientific approach invites students to think creatively starting from observing, questioning, trying, analyzing, and communicating through simulation activities in the module

The application of scientific learning approach in accordance with Doppelt's opinion, (2003) on active learning in constructivism-based learning, where students will be easier to know and understand concepts through active thinking and problem solving, and that students learn in the realm of not only remembering but also doing knowledge building activities with exercises given by teachers or homework contained in books (Doppelt, 2009). Students are responsible for learning events and learning outcomes. This is in line with the opinion expressed by Triwiyono, (2011) that learning with guided experiments is more effective in improving students' high-level thinking skills compared to conventional learning.

Researchers have done many other studies to improve creative thinking skills, such as the use of worksheets and modules (Klieger &Sherman, 2015; Romli, Abdurrahman, &Riyadi, 2018), the use of incuiahy learning models, STEM (Li, Li, Mo, &Li, 2018), project-based learning (Diawati et al., 2018; Mihardi, Harahap, &Sani, 2013), and problem-based learning (Yoon, Woo, Treagust, &Chandrasegaran, 2015). The use of PBL and other models has been done by other researchers to improve students' creative thinking skills. However, this scientific-based electronic science module in addition to improving students' creative thinking skills, can also facilitate students in distance learning during the covid-19 pandemic. This is what distinguishes this research from other studies.

The use of electronic modules gives students the opportunity to learn and practice solving problems independently through materials presented and evaluation questions lead students to solve problems creatively and independently. This will provide a concrete experience in problem solving so that it fosters and trains high-level thinking skills including creative thinking skills. (Kamalasari, 2019) . In addition, according to (Fisher, 2019) students are concerned that the e-learning-based scientific approach provides a new learning experience where students have the opportunity to learn from many sources, while utilizing various features of information technology with all the advantages it has so that students get an improved creative thinking ability.

Conclusion

Based on the results of data analysis, the N-gain values for indicators consisting of fluency, flexibility, originality, and elaboration were 0.39, 0.58, 0.59 and 0.45, respectively. This number means that creative thinking is included in the medium category. Further analysis shows that, by using a scientifically based electronic science module on vibration and wave material, students' creative thinking skills can increase, especially on the originality indicator.

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