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RESEARCH ARTICLE

APPLICATION OF STEM-Cp BASED MAGNETIC FIELD AND ELECTROMAGNETIC INDUCTION MODULE TO IMPROVE STUDENTS CREATIVE THINKING SKILLS AT VOCATIONAL HIGH SCHOOL

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Abstract

Materials in physics learning at school are considered difficult to understand, especially in the concept of magnetic field and electromagnetic induction. Contextual issues are required to overcome this problem.STEM-Cp (science, technology, engineering, mathematics-contextual problem) is seen to help students understand the concept of magnetic field and electromagnetic induction through contextual issues. The purpose of this study was to determine the effect of using STEM-Cp based moduleon students' creative thinking skill on magnetic field and electromagnetic induction material.The research design used in this study is one-group pretest-posttest design . Data obtained from the results of creative thinking tests conducted in the experimental class before and after learning. The results showed that the students' creative thinking skills taught using magnetic field modules and electromagnetic induction based on STEM-Cp before and after learning improved. The effect of the application of the magnetic field module and electromagnetic induction based on STEM-Cp has an average increase of 80,3in the good category. This shows that the creative thinking skills of students learning with magnetic field modules and electromagetic induction are better than before being applied in learning.

Introduction:-

The magnetic field and electromagnetic induction is considered one of the physics materials that difficult to comprehend, so that the score of understanding the concept of magnetic fields and electromagnetic induction is in the low category, the lack of concept mastery occurs in students understanding the direction of the field and the magnetic force(Hekkenberget al., 2015).Understanding this concept requires an approach that integrates several disciplines into a single unit which is expected to be able to overcome them and to enable students to think creatively.One approach that can be considered to help improve scientific literacy and creative thinking skills is the STEM approach

STEM education (Science, Technology, Engineering, and Mathematics) needs to be developed as a solution to face the challenges of the 21st century (Bybee, 2013).STEM learning is able to help students to keep up with technological advances in the 21st century (Ostler, 2012). Learning using STEM can help students solve problems and draw conclusions from previous learning by applying them through science, technology, engineering and

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mathematics (Robert & Cantu, 2012; Louet al.,2017).Teachers must have the same characteristics as STEM so that they can teach according to current demands (El Nagdi et al., 2018). The STEM (Science, Technology, Engineering, and Mathematics) approach is an important issue in education in the current era(Becker & Park, 2011).STEM education greatly contributes to assisting learning in the 21st century(Dong et al., 2019). STEM as an approach to teaching two or more STEM subjects related to authentic practice so as to increase students' interest in learning (Kelley & Knowles, 2016).The STEM approach combines several disciplines in one unit which are expected to be able to produce competent and quality graduates, both in mastering the concept and its application in life. Mastery of the concept of magnetic field material and electromagnetic induction can be overcome by using the STEM approach, besides that, contextual problems are needed that are relevant to students' daily lives so that learning is more meaningful. The contextual problem in question is a real contextual problem that occurs in students' daily lives and is displayed to help understanding concepts.Understanding this concept requires an approach that integrates several disciplines into a single unit which is expected to be able to overcome them and to enable students to think creatively.

Creative thinking is one of the thinking skills needed by students to be able to solve problems in people's lives, creative thinking is an important aspect of critical thinking (Deschryver and Yadav, 2015).Creativity is the skill to produce new, appropriate products with high quality (Stenberg et al., 2002). The level of creative thinking of the Indonesian people is generally still low. Based on the measurement results of the last 2015 Global Creativity Index (GCI) this shows that in terms of creativity, Indonesia ranks 115 out of 139 countries(Florida et al., 2015). Creative thinking skills are measured by aspects of fluency, flexibility, elaboration, problem sensitivity, originality (Guilford, 1995). Low creative thinking skills need to be improved in order to face the very rapid advances in science and technology, so that teaching materials are needed that can help understanding concepts in learning physics.

The module is one of the right steps to improve the quality of learning for students, because currently the development of teaching materials in the form of modules is very much needed. The use of modules is expected to be able to condition learning activities that are well planned, independent, complete, and with quality results. This STEM-Cp based magnetic field and electromagnetic induction module discusses science, technology, engineering and mathematics aspects with very contextual problems with students, especially vocational students. In addition, this module makes physics learning more enjoyable and provides opportunities to optimize students' potential in producing products. This module is the result of the development of a physics module with magnetic field and electromagnetic induction materials that have passed the validity and practicality test of expert and user validators.

The purpose of this study was to determine the effect of the application of the STEM-Cp module on improving students' creative thinking skills.

Research Method:-

This type of research is quantitative research. The research design used in this study is one-group pretest-posttest design. In this study, students were given an initial measurement (pretest) to determine the level of understanding of the concept before being given treatment. After being given treatment, students are given further measurements in the form of a post test to measure the level of mastery of the concept of magnetic fields and electromagnetic induction after receiving treatment. The research design is as follows:

Table 1:- One-group pretest-posttest.

Pretest	Intervention	Posttest
O_1	X	O_2

Sugiyono, 2015

O_1 : Pretest value

X : Treatment

O_2: Posttest value

The research used a quasi-experimental research method without a control class.The class used in this study is class X SMK with a total of 36 students.The data was collected by means of a creative thinking test. Creative thinking tests are carried out before and after learning. In this study, questions were developed according to Guiford's creative thinking indicators, namely aspects of fluency, flexibility, originality, problemsensitivity and elaboration in thinking.

The calculation of the score for creative thinking skills is done by giving a score on each question based on the emergence of each aspect of creative thinking skills that is the student's answer.

$$\text{Scores of students' creative thinking skills} = \frac{\text{achievedscore}}{\text{maximumscore}} \times 100$$

In this study, for the instrument of creative thinking skills, researchers used the following criteria:

Table 2:- Criteria for the level of creative thinking.

Score	Criteria
81 - 100	Very Good
61 - 80	Good
41 - 60	Enough
21 - 40	Less
0 - 20	Very Less

Result and Discussion:-

There are 2 modules made in this study, namely module 1 on magnetic field material and module 2 on electromagnetic induction material. The creative thinking score in Module 1 can be seen in Figure 1 and Module 2 in Figure 2.

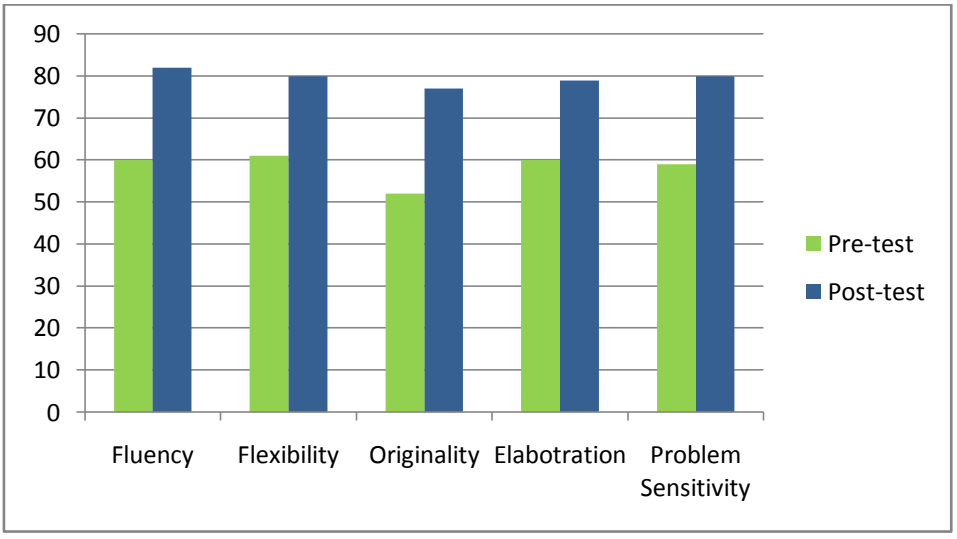

Figure 1:-Graph of the pretest and posttest scores for each indicator of students' creative thinking skills in module 1.

Table 3:- Score of each creative thinking aspect in module 1.

Aspect	**Postest**	**Criteria**
Fluency	82	Very Good
Flexibility	80	Good
Originality	77	Good
Elaboration	79	Good
Problem sensitivity	80	Good

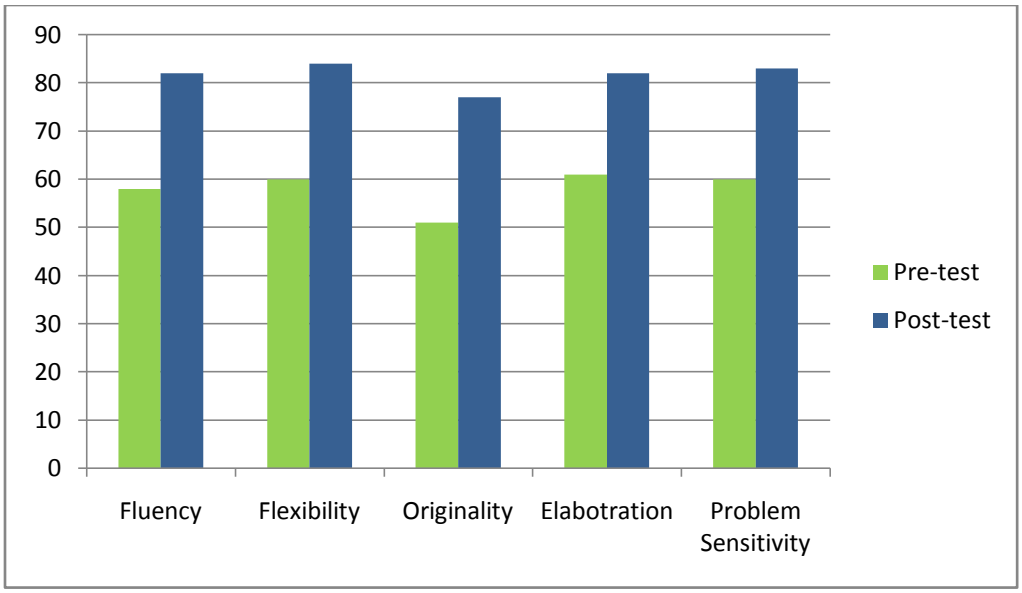

Figure 2:- Graph of the pretest and posttest scores for each indicator of students' creative thinking skills in module 2.

Table 4:- Score of each creative thinking aspect in module 2.

Aspect	Postest	Criteria
Fluency	82	Very Good
Flexibility	84	Very Good
Originality	77	Good
Elaboration	82	Very Good
Problem sensitivity	80	Good

The purpose of this study was to determine the effect of using the STEM-Cp module on magnetic field materials and electromagnetic induction. The results show that the use of the STEM-Cp module has an effect on students' creative thinking. This result can be seen from the results of the posttest in the two modules which have a higher score than the pretest on all aspects of creative thinking. The questions used to obtain pre-test and post-test data include five aspects of creative thinking, namely aspects of fluency, flexibility, originality, elaboration and problem sensitivity. Fluency includes the ability to come up with many ideas, solve problems, and provide many suggestions or suggestions. The fluency aspect is raised in STEM-Cp which makes students always think of more than one answer. Flexibility includes a variety of ideas in solving problems.Variation of ideas as a form of creativity by students. Flexibility appears in STEM-Cp. Contextual problems are solved with various answers from the STEM approach. Originality is more about solving contextual problems with unique ideas. Elaboration lies in enriching and developing an idea or product, adding or detailing the details of an object, idea, or situation so that it becomes more interesting. Meanwhile, the problem of sensitivity is more on the student's response to the problem.Problem sensitivity is sensitivity to problems by recognizing the existence of a problem or ignoring facts that are not suitable to recognize the real problem.

The essence of STEM learning is to solve environmental problems with the understanding or scientific knowledge that is being studied. One indicator of creative thinking is being able to solve contextual problems very well. Contextual learning also makes it easier for students to apply the concepts that are being studied in life (Widayoko et al., 2018). The results showed that the student response was very good in learning.

The criteria for fluency, flexibility, and elaboration in module 2 have very good criteria. This criterion increases from the application of module 1. In module 1 only the fluency criteria have very good criteria. This increase was accompanied by posttest scores which increased along with the increase in students' creative thinking.

Conclusions and Suggestion:-

Conclusion:

There is an effect of creative thinking using STEM-Cp. This can be seen from the results of the posttest on the first and second modules that continue to experience remembrance. These results indicate that classroom learning with STEM-Cpmodule can improve students' creative thinking skills effectively.

Suggestion:-

For readers, you should first understand the definitions of STEM-Cp. For advanced researchers, STEM-Cp orientation can be applied to measure other skills as research dependent variables.

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