Application of STEM-based online learning to train creative skills of students in covid-19 pandemic periods

F Sarnita 1*, A Fitriani 1, Anhar 1, J A Utama 2, I R Suwarma 3 and Widia 3

1Department of Physic Education, STKIP Taman Siswa Bima, Bima, Indonesia.
2Department of Sports and Recreation Education, Universitas Pendidikan Indonesia.
3Department of Natural Science Education, STKIP Harapan Bima, Indonesia.

*fitriasarnita21@gmail.com

Abstract. This aim of this research application of STEM learning with the 6th-semester student object of physics education study program STKIP Taman Siswa Bima. The research subject is creative thinking skills. This study uses a One Group Pretest - Posttest Design with Pretest design; to measure students' creative thinking at the beginning of learning (Y_1), Implement STEM (X), and Posttest based learning; to measure students' creative thinking at the end of learning (Y_2). The instruments in this study were student activity sheets, student response questionnaires, and instruments for assessing students' creative thinking skills using open-ended questions via Google Form and assessing creative products produced by students. Student responses and activities were analyzed in terms of percentages, while for creative thinking skills students were analyzed descriptively qualitatively using N-Gain. The instruments in this study used open-ended and prototype tests. The test is used to see the level of creative thinking of students, while the prototype is used as an assessment of students' creative products. Analysis of creative thinking skills with an average value of 78 is at the creative level, while creative products (prototype) with an average value of 84 are at a very creative level. So it can be concluded that the application of STEM-based online learning can train students' creative thinking skills during the COVID-19 pandemic.

1. Introduction

Covid-19 pandemics force countries to implement physical distancing and social distancing as well as in Indonesia. Through the Minister of Education and Culture (Mendikbud) following up on the policy issuing Circular Letter (SE) Number, 4 of 2020 concerning the Implementation of Education Policy in the Emergency Period of Covid-19 Distribution, among those policies is the process of Learning from Home through online / distance learning implemented to provide a meaningful learning experience for students, without being burdened by the demands of completing all curriculum achievements for grade and graduation. This means that learning takes place based on the needs of students by utilizing existing information technology.

Online learning or Distance Learning which we often call E-learning. Milman said the use of digital technology allows students and lecturers to be in different places during the learning process [1].
Students as intellectuals can access learning independently, manage media, and use gadgets as learning resources. The use of mobile technology has a major contribution to the world of education, including the achievement of distance learning goals [2]. Various media can also be used to support the implementation of online learning. For example, virtual classes use Google Classroom, Edmodo, and Schoology services [3].

Educational experts in various countries are trying to develop models and learning strategies that are suitable for current conditions, especially during coronavirus disease 2019 (COVID-19) which requires us to limit activities, schools have to be closed because they are expected to break the chain of the spread of viruses this ferocious. So that we too as practitioners of tertiary education use STEM as an alternative to running the online learning process. STEM encourages students to design, develop, and utilize technology to improve their cognitive abilities, skills, and scientific attitudes. Teaching using media and technology could help student in understanding the concept [4]. The four strands of STEM: Science, Technology, Engineering, and Mathematics, have been stapled forms of all students' academic careers; particularly science and mathematics [5]. These four fields of knowledge can make knowledge more meaningful if it is integrated into the learning process. STEM-based education is not only focused on developing the ability of students in the fields of science, technology, engineering and design, and mathematics but also seeks to grow soft skills. STEM's first steps are reflection, which is to find out the extent of students’ interest in learning. The next step is research, discovery, and application (trial). The last step is presentation.

STEM-based learning is expected to be able to train students’ creative thinking skills. According to [6] creative thinking skills are thought with all directions, provide many alternatives, think quickly, and openly when faced with a problem. There are three features of creativity defined by Torrance [7]; fluency, flexibility, and originality. Fluency, which refers to the number of answers given by the student about a problem. Flexibility can be thought of as the student’s potential to change from one type of thinking to another one when creating solutions. Originality is described as the ability of an individual being able to come out with unique ideas like to do unexpected things or show different abilities from others [8].

2. Methods
This study uses a One Group Pretest - Posttest Design with Pretest design; to measure students’ creative thinking at the beginning of learning (Y_1), Implement STEM (X), and Posttest based learning; to measure students’ creative thinking at the end of learning (Y_2). The instruments in this study were student activity sheets, student response questionnaires, and instruments for assessing students' creative thinking skills using open-ended questions via Google Form and assessing creative products produced by students. Student responses and activities were analyzed in terms of percentages, while for creative thinking skills students were analyzed descriptively qualitatively using N-Gain. This research is oriented to individual creative thinking and prototype products made by students, the subjects in this study are physics students in the 6th semester of STKIP Taman Siswa Bima with the following research designs:

![Design of research](image)
The first stage is learning online by online students in basic physics instrument classes are divided into 5 groups to design simple prototypes, make designs, and finish products. Then the second stage is apply STEM stages by using the g-form and zoom to find out students' interest in learning, prototype testing, and presentations. Third phase is evaluation of learning outcomes, does STEM learning already meet the elements of creative thinking in students or not?

3. Result and Discussion

The results of data analysis on STEM-based online learning in training creative thinking skills for physics education study program students at 6th-semester STKIP Taman Siswa Bima can be seen in Table 1 below:

3.1. Creative Thinking Skills of Person

![Figure 2. Results of analysis students person of creative thinking skills](image)

The chart above is the result of individual student's creative thinking skills test in terms of the criteria of creative thinking: fluency, flexibility & originality. The test given is a type of open-ended question to know the level of creative thinking skills of individual students. Based on the data above shows that three students are still less skilled in creative thinking. Third students 58%, fifth students 58%, and tenth students 63%. But basically, all children can think creatively with an average of 78 (creative), it's just different levels. According to [9], research on creativity shows that almost all children possess creative thinking skills at different levels.

Just how the role of educators design learning so that it triggers students to think, such as making questions or assignments to solve problems. Teachers should create a learning environment where students can feel and produce authentic ideas to develop creativity at school [9], reflective abstract alone is insufficient for generating creativity [10]. Because one of the triggers for the emergence of creative thinking is when someone faces a problem, to solve the problem someone will try to find a solution, bring up new ideas, and then take steps to solve the problem. So hopefully when students can solve problems in school with creative elements, then these students can also solve problems in their daily lives.
Figure 3. Results of analysis students N-gain of creative thinking skills.

The graph above shows that there is an increase in the creative thinking skills of Physics students in the 6th semester of STKIP Taman Siswa Bima. The range of N-gain scores is between 0.31 (medium category) - 0.79 (high category) and the average N-gain calculation is 0.55 (medium category). But different cases occur in students numbers 3, 5 & 10, where the difference in value between the pre-test and post-test is not too far away, thus affecting the N-gain. N-gain of third, fifth, and tenth students; .31., .34., & .35. Even though they are less skilled in creative thinking, they still respond positively to STEM-based learning, because students are increasingly motivated and interested in the learning process [6] and they hope to be taught by the same methods in subsequent lectures. So it is deemed necessary for educators both teachers and lecturers to design learning that can train students’ creative thinking, is needed special attention, continue to be trained and accustomed to how to think about divergence, provide many alternatives, think quickly and openly when faced with a problem [6].

3.2. creative thinking skills of product
STEM-based learning applied in this study also produces a simple prototype product, the product is made to see the creativity of students in designing prototypes in physics basic courses. Students are divided into 5 groups, data on the results of assessing the creative products of students as follows:

Table 1. Physics student product assessment results.

| Group | Score of Product |
|-------|------------------|
| A     | 90               |
| B     | 85               |
| C     | 80               |
| D     | 80               |
| E     | 85               |
| **Average** | **84** |

Table 1 shows the value of students’ creative products is at a vulnerable value of 80 (creative) - 90 (very creative) with an average value of creative products 84 (very creative). Creativity is often associated with a creative product [14] and provides a starting point for creative products [11]. Most problems faced by students in schools may require the ability to read carefully and thought but a little creativity. However, many problems we face in life are not following the wishes [12]. Creativity is distinct from intelligence, creativity is motivated by problem finding [13].
4. Conclusion
Based on the results and discussion it can be concluded that there is an increase in students’ creative thinking skills using STEM-based learning. STEM-based learning provides space for students to realize the principle of freedom of learning. Learning takes place should be oriented to authentic problems, so students are accustomed to thinking because creativity refers to the capacity to overcome the given problem. So cooperation is needed from various parties to realize it all.

5. References
[1] Milman N B, 2015, Distance Education, in International Encyclopedia of the Social & Behavioral Sciences: Second Edition, .
[2] Korucu A T and Alkan A, 2011 Differences between m-learning (mobile learning) and e-learning, basic terminology and usage of m-learning in education in Procedia - Social and Behavioral Sciences.
[3] Enriquez M A S, 2014 Students ’ Perceptions on the Effectiveness of the Use of Edmodo as a Supplementary Tool for Learning DLSU Res. Congr.
[4] Suwarma I R Kaniawati I and Kaniawati D S, 2019 Engaging Students in STEM Based Learning Through Media and Technology in Journal of Physics: Conference Series.
[5] Gonzalez H B and Kuenzi J, 2012 What Is STEM Education and Why Is It Important? Congr. Res. Serv.
[6] Satriawan M et al., 2020 Physics learning based contextual problems to enhance students’ creative thinking skills in fluid topic in Journal of Physics: Conference Series.
[7] Şener N and Taş E, 2017 Improving of students’ creative thinking through purdue model in science education J. Balt. Sci. Educ.
[8] Kuo P H, 2016 Effects of synchronous web-based instruction on students’ thinking styles and creativity Eurasia J. Math. Sci. Technol. Educ.
[9] Türkmen H, 2015 Creative Thinking Skills Analyzes of Vocational High School Students J. Educ. Instr. Stud.
[10] Arlin P K, 1977 Piagetian operations in problem finding Dev. Psychol.
[11] Chand I and Runco M A, 1993 Problem finding skills as components in the creative process Pers. Individ. Dif.
[12] Slavin R E, 2005 Cooperative Learning: Teori, Riset dan Praktik .
[13] Kim K H, 2011 The Creativity Crisis: The Decrease in Creative Thinking Scores on the Torrance Tests of Creative Thinking Creat. Res. J.

Acknowledgments
Thank research team to KEMENRISTEK DIKTI BRIN have charge this is research with contract number: 1064/LL8/PG/KM/2020 Indonesia who assisted in funding this research 100%. Chairperson of STKIP Taman Siswa Bima for allowing us to conduct research, UPI Campus allowed us to cooperate in this research, the authors thank NASA’s Jet Propulsion Laboratory has provided access to public data for the purposes of this research, thanks also to the Editorial Team of the Aerospace Science Journal and Bestari Partners and all those who helped in this research process which cannot be mentioned one by one.