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Implementation of Project Based Learning Through the STEMC Approach to Improve Students' Creative Thinking Skills

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Abstract: The purpose of this study was to investigate the improvement of students' creative thinking skills by implementing STEMC-based project-based learning. This study consisted of 52 students of class X science at SMAN 3 Langsa. Creative thinking ability was assessed through pretest-posttest which was tested using statistically paired sample t-test and N-gain test. The results of the study stated that the application of the STEMC-based PjBL model on electrolyte and nonelectrolyte materials had increased creative thinking skills at a significant level of 0.000, indicating a sig value <0.05 and the results of the N-gain calculation were 0.8 in the high category. The results of the analysis showed that there were differences in the improvement of creative thinking skills before and after the application of the STEMC-based PjBL model. The results of the N-gain of each indicator of creative thinking ability, namely 0.47 elaboration are classified in the medium category, while flexibility, fluency and originality with N-gain results of 0.97, 0.87, and 0.8 are classified in the high category.

Keywords: PjBL model; STEMC approach; Creative thinking ability; Entrepreneurial spirit

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Introduction

The 21st century is a current of globalization that increases all the challenges of various lives so that it requires educational institutions to produce quality generations who can adapt to the various challenges of the current flow of globalization (Kurniahtunnisa et al., 2020; Kuncahyono & Aini., 2020). Students are required to find their own information, think critically, have creativity, can identify and solve problems. An important part in active learning is how to connect students with everyday life so as to give meaning to learning to students. Based on Ausubel's theory, (1977) states that meaningful learning means learning ideas, concepts, and principles through associating new information with information that already exists in the memory of students. This is included in the theory of constructivism approach.

The fact is that there are still many students who have low critical and creative thinking skills so that learning innovation is needed to increase student motivation in learning and improve student skills through direct involvement in exploring knowledge (Safaruddin et al., 2020). Reform efforts, the ministry of education and culture, and many researchers are trying to develop a more flexible education so that it can integrate a combination of disciplines (Sacchi et al., 2021). One of the ways to explore the creative thinking potential of students is in the fields of Science, Technology, Engineering and Mathematics (STEM) to face various challenges in the 21st century. STEM has been recognized in various parts of the world as a publication with a hot topic, which is very important to

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be applied in the world of education (Jho et al., 2016; Li, et al., 2020; Zizka et al., 2021).

Indonesia is currently also trying to transform the educational process using the STEM approach. One of them is in Aceh who is committed to implementing learning with a STEM approach, but there are differences in the concept of STEM in Aceh, namely the emphasis on character, so that STEM is formed into STEMC, where C refers to "Critical Thinking, Creativity, Collaboration, Communication, Computational Thinking + Character", which shows that in Aceh it does not only focus on the competencies possessed by students but also on the character of students. In addition to using a learning approach, to support creative thinking skills, a learning model is needed, one of which is through the Project Based Learning mode (PjBL). Through STEM-based PjBL, students will learn by doing and are encouraged to develop new experiences while perfecting their ideas (Margot & Kettler, 2019).

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The results of observations at SMAN 3 Langsa City obtained from interviews with teachers stated that students still have difficulty remembering the chemical material being taught, students are also less creative in answering questions given by the teacher. This is based on the results of the average daily test of students who are still below the minimum criteria of mastery learning. Then the teacher also said that the learning activities applied were less varied and the teacher had never implemented STEM learning. Therefore, because of the many advantages of STEM learning, it is necessary to apply it to chemistry so that students are trained in their abilities

Method

This research was conducted at SMAN 3 Langsa for the academic year 2021/2022. The classes studied are class X IPA 5 with a total of 25 people and X IPA 6 with a total of 27 people. This research was conducted in 3 meetings on non-electrolyte electrolyte lessons. This study consisted of an experimental class without any control treatment. The design form used is Pre-test Post-test Control-Group (Fraenkel,2012).

During treatment, students will be given STEMC-based worksheets based on the engineering design process (EDP) to make it easier for students to work on projects. This research uses quantitative research. Quantitative data in this study were obtained by conducting pre-test and post-test on students. Measurement of creative thinking skills using a test instrument in the form of essay questions measured by indicators of creative thinking skills adapted from Torrance (1969).

Creative thinking ability data was assessed by scoring rubric. It can be calculated by the percentage formula (Sabaniah, et al, 2019) as follows:

$$\text{Score} = \frac{student\ answer\ scores}{max\ score} x\ 100\% \quad (1)$$

The data obtained will be analyzed using a paired sample t-test, namely to see the difference in the average sample before and after treatment (Montolalu & Langi., 2018).

Result and Discussion

The test instrument is in the form of descriptive test questions to measure students' creative thinking skills which are validated qualitatively and quantitatively. Qualitatively, the test instrument was validated by 2 experts with the aspects studied in the form of material, construction, and language assessment so that the instrument used was valid and feasible to use. Quantitatively, the description test instrument was tested using a proanal test developed by Khaldun (2020). Based on the calculation results, there are 5 questions that are valid and reliable and suitable for use with a reliability value of 0.748 with a high category.

The analysis of increasing students' creative thinking skills was obtained based on calculations using t-test and N-gain. Testing the hypothesis to see the increase in creative thinking skills was analyzed using the paired sample t-test with a significance value of 0.05. The condition for testing the hypothesis first is to test whether the data is normally distributed.

The data from the normality test using the Shapiro-Wilk test showed significant results in the pretest data (0.060)> (0.05) and posttest sig (0.050) = (0.05) so it can be concluded that the two data are normally distributed and can be continued for hypothesis testing using the paired test. sample t-test. This t-test was conducted to determine the increase in creative thinking skills before and after the implementation of PjBL-STEMC.

Based on the t-test data, it shows that with a significance level of 5% with sig (0.000) <(0.05) then H0 is rejected. Ha is accepted so that it can be concluded that there is a significant change between before and after treatment which indicates a significant increase in creative thinking skills. This is in accordance with Hanif, et al (2019) who said that Project-based STEMC had a good impact on student creativity.

The increase in students' creative thinking skills can also be seen by calculating the N-gain from pretest and post-test data. The average score of creative thinking skills can be seen in Figure 1.

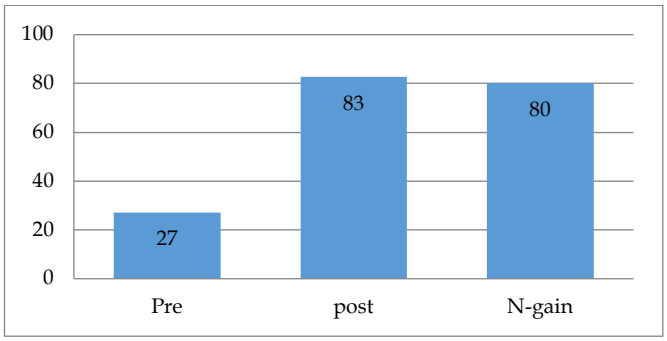

Figure 1. The Mean Score of Pretest, Posttest and N-gain

Based on the diagram above, it is known that the value of students only got a score of 27, after using the STEMC-based PjBL model there was an increase in the average score of 83 with an N-gain of 80 or 0.8 which was classified in the high category. This shows an increase in students' creative thinking skills after using the STEMC-based PjBL model. Widyasmah, et al (2020) said that learning that was given treatment with the STEM approach showed an increase in students' creative thinking skills with an average N-gain value of 0.4 which was classified in the medium category. This indicates that the application of the PjBL-STEMC model that involves students actively in learning activities and assists students in answering and solving problems in everyday life will have an impact on the creative thinking power of students. designing products using STEM provide opportunities to increase creativity (Siew., 2017; Hathcock et al., 2015).

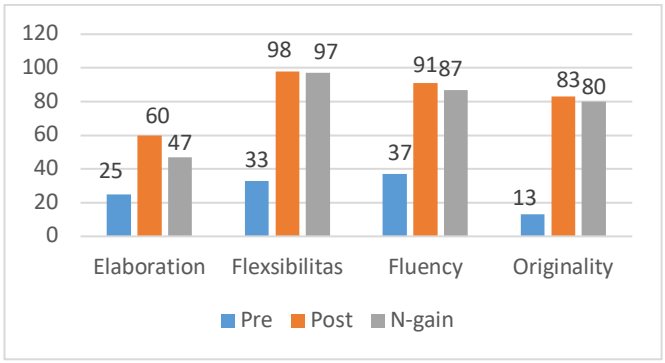

Figure 2. N-gain for Each Indicator of Creative Thinking

Based on the N-gain data for each creative thinking indicator, different results are obtained. The results of the N-gain calculation on the elaboration indicator, namely 0.47, indicate the medium category. In the indicators of flexibility, fluency and originality the results of N-gain obtained are 0.97, 0.87 and 0.8, respectively, indicating the high category. The data obtained on the Elaboration aspect showed an increase from the average before the application of PjBL-STEMC to 60 after treatment. This is because the use of STEMC during learning requires students to get used to connecting the material with everyday life, developing ideas and adding the best solutions to solve problems when working on projects of making electrical conductivity test equipment and making isatonic beverage products. Sirajudin et al., (2021) said that learning activities using the STEM approach directly provide students' experience to be able to combine every aspect at once. The stages of learning that are integrated with these four aspects make it easier for students to understand the learning material.

Improvement in each indicator of creative thinking ability shows that PjBL based on STEMC is able to direct students to be actively involved, understand concepts and be able to relate information obtained related to electrolyte and non-electrolyte material in real life. Among the creative thinking indicators, the N-gain elaboration indicator gets a lower percentage, this shows that students are still lacking in detailing the explanation of the answers given. This also agrees with Widyasmah, et al (2020) who say that students are fluent (Fluency) in identifying problems, but in terms of detailing the answers are still not precise so that they do not fully meet the elaboration and originality indicators.

The data obtained on the aspect of flexibility showed an increase from the average before the application of PjBL-STEMC which was only 33 to 98 after treatment. The increase shows that there is an effect on the use of learning using PjBl-STEMC on the way students think by using a different-based point of view. This is because during the application of treatment, students are required to make their own designs when making electrical conductivity test equipment and isatonic drink products, where during the project design process students must interpret concepts from various points regarding the project being worked on. The results of Somwaeng's research (2021) say that practicing science, mathematics and technology skills and bringing knowledge to design works or create works in finding needs or solving problems related to everyday life is proven to be able to develop children's flexible thinking abilities.

The data obtained on the fluency aspect showed an increase from the average before the application of PjBL-STEMC which was only 37 to 91 after treatment. An increase shows the use of learning using PjBl-STEMC on

the fluency/fluency of students in answering the questions given. This is because during the learning process using the STEMC-based PjBL model will direct students to think critically, think computationally, communicate and collaborate, where students will observe the problem formulation of the project, seek information from various sources to find the right solution so that during the process In this way, students get the knowledge / information obtained related to materials and projects that are carried out correctly and clearly. This is supported by the research of Widyasmah et al., (2020) which said that after implementing the Project-based STEM approach, students met the fluency indicator, where students became more skilled in writing from what was known and asked.

The originality aspect, directs students to produce unusual ideas (Altan & Tan., 2020). Based on the pretest-posttest data on the originality aspect after the implementation of PjBL based on STEMC, it showed an increase from 13 to 83. There was an increase in the originality aspect because during the learning process students had to develop the latest ideas to make istonic drink products that were different from packaged isatonic drinks. which are traded in the market. This makes students to make something different from what existed before. This is also evidenced by research conducted by Muhibbudin et al., (2019) which says that the application of STEM-based worksheets in the experimental class is really effective in improving students' creative thinking abilities, originality. Firdaus et al., (2018) said that students who already have the ability to think original will make it easier for students to respond to a problem or find new and innovative ways.

Conclusion

Based on the results of the research that has been done, it can be said that the creative thinking ability of students after implementing the STEMC-based PjBL learning model has increased. Based on the N-gain data for each indicator, creative thinking gets different results. The results of the calculation of N-gain on the elaboration of indicators are 0.47 indicating the medium category, indicators of flexibility, fluency and originality The N-gain results obtained sequentially are 0.97, 0.87 and 0.8 indicating the high category. This proves that the STEMC approach can be used as a creative formation process for students in learning so that it can be applied in everyday life.

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