




## Implementation of STEM-Based PjBL with Design Thinking Strategies to Improve Student's Creative Thinking Skills on Global Warming Materials

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### Abstract

*This study aims to determine the effect of PjBL-STEM learning with design thinking strategies on students' creative thinking skills on global warming material. This research was conducted at public high school Pringsewu with a research design that is non-equivalent control group design. The research instrument used was a description test. Learning using PjBL-STEM with a design thinking strategy improves students' creative thinking skills, this is indicated by the average value of the experimental class N-gain of 0.6130 which is greater than the control class with an average value of 0.5051 N-gain which is in the moderate category. Based on this data, it shows that the creative thinking ability of students has a significant difference between the experimental class and the control class. This is also supported by the data from the Independent Sample t-test hypothesis test results obtained Sig value. 0.003, it can be decided that the application of PjBL-STEM with a design thinking strategy can improve students' creative thinking skills on global warming material.*

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## 1. Introduction

The development of knowledge, academic ability, and thinking skills in learners is a challenge in 21<sup>st</sup> century learning. This challenge can be faced by implementing learning innovations that stimulate 21<sup>st</sup> century skills include creative thinking, critical thinking, collaboration, and communication skills which are recognized as competency standards that learners need to have to meet the demands of future life [1]. One of the 21<sup>st</sup> century skills that must be mastered by learners is creative thinking [2]. Creative thinking skills play an important role in the learning of all learners and are part of the higher order thinking skills that need to be developed. When learners pay attention to the learning process, creativity will increase understanding and encourage cognitive development [3]. The characteristics of the independent curriculum are in its problem and project oriented learning [4]. The problems discussed in the independent curriculum are energy conservation and global warming, this aims to increase students' awareness of environmental issues around them [5].

Based on the results of interviews with educators of SMA Negeri 2 Pringsewu, it is known that in the learning process students are given a concept, which in the learning activities educators only transfer knowledge to students, and are given practice problems related to the concepts that have been given. Students still tend not to be able to solve physics problems in new or innovative ways. Students also have not fully learned to apply physics concepts in making a real work. In addition, the learning process does not invite students to be actively involved in learning and applying the material to the real world.

This makes students bored and less enthusiastic about the lesson, causing them to become passive. In fact, the learning process will be more effective if students actively participate in the learning process.

The role of the teacher is not only as a transfer of knowledge or the teacher is the only source of learning who can do anything (teacher center), but the teacher as an active mediator and facilitator to develop the active potential of students who exist in themselves. The solution to realize the success of teaching and learning activities is the selection of the right learning model, in improving the ability to think creatively, the right learning model is the project-based learning model [6].

Project Based Learning is one of the most widely adopted innovative teaching models to face future challenges [7]. Another way to improve students' creative thinking skills is with the STEM (Science, Technology, Engineering, and Mathematics) approach because it is suitable for creativity, because the engineering process is a process of training creativity. STEM implementation can fulfill the integration of skills and content in the 21<sup>st</sup> century [8]. PjBL-STEM makes students actively involved and participate in the learning process [9]. On the topic of global warming, it has not been widely used in the form of integrated learning PjBL-STEM design thinking. Combining the PjBL-STEM learning model with design thinking strategies is often in the form of project-based learning, which is a major change in the learning process [10]. This is because through STEM integrated design thinking, students are given the opportunity to realize creativity or ideas in solving surrounding problems and can improve 21<sup>st</sup> century skills [11].

Based on the description of the background of the problem above, the PjBL (Project Based Learning) learning model which is integrated with the STEM (Science, Technology, Engineering, and Mathematics) approach with a design thinking strategy is an alternative solution to improving students' creative thinking skills, so researchers conducted research on the implementation of PjBL-STEM with design thinking strategies to improve students' creative thinking skills on global warming material.

## 2. Methods

This study use a quantitative approach and including quasi eksperimental. Research design used is nonequivalent pretest posttest group design because on this study want to see difference students Physics learning outcomes in control class and experiment class. As for pattern from the research design used displayed by Table 1.

**Table 1.** Quasi-Experimental Design

Class	Pre-test	Treatment	Post-test
Experiment	<b>O<sub>1</sub></b>	<b>X<sub>1</sub></b>	<b>O<sub>2</sub></b>
Control	<b>O<sub>3</sub></b>	<b>C</b>	<b>O<sub>4</sub></b>

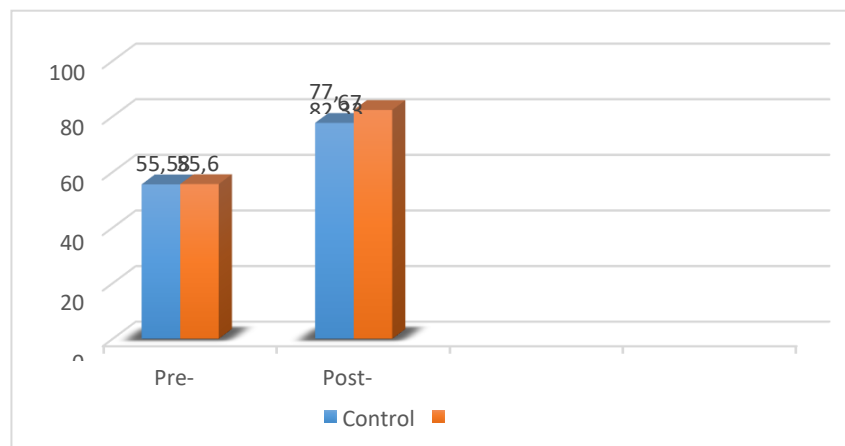
Information:  $X_1$  = giving treatment form learning with use model PjBL-STEM with design thinking strategies,  $X_2$  = giving treatment form learning with use conventional learning model,  $O_1$  and  $O_2$  = pre-test and post-test class experiment,  $O_3$  and  $O_4$  = pre-test and post-test control class.

This research was implemented in SMAN 2 Pringsewu in 2023/ 2024 academic year. The population research is all over student class X SMAN 2 Pringsewu, taking sample done with technique purposive sampling, obtained results that class X-4 as class experiment and class X-5 as class control. The data collection technique uses student learning outcomes based on pre-test and post-test using a 10-item description test instrument at the C4-C6 cognitive level. The pretest and post-test question instruments were carried out in the experimental class and control class with the same question format. The pre-test questions given before treatment have the same form and number as the post-test questions after treatment.

The data analysis technique used the N-gain test to see the increase in students' creative thinking skills in experimental and control classes. Then the data was analyzed using t-test to see the effect of PjBL-STEM model with design thinking strategy on creative thinking ability of students of SMAN 2 Pringsewu. Results and discussion can be used as one unit that contains research findings and explanations.

### 3. Results and Discussion

Learning activities were carried out for four meetings with material on global warming. Before learning begins, researchers give a pretest to see the initial abilities of students. After the learning activities were completed, the researchers gave a posttest to see the abilities that students had achieved after applying the PjBL-STEM model with design thinking strategies in the experimental class and the conventional learning model in the control class. The average pre-test and post-test and post-test scores for the experimental and control classes can be seen in Figure 1.



**Figure 1.** Students Learning Outcomes of Control Class and Experimental Class

Based on Figure 1, the results shows a comparison of the average pre-test and post-test scores in the control class and experimental class. In the control class, the average pre-test score was 55.58 and the average post-test score was 77.67. In the experimental class, the research data showed that the average pre-test score for the experimental class was 55.67 and the average post-test score was 82.33.

**Table 2.** N-gain Test Result

Class	N-gain Score			Category
	lowest	highest	Average	
Experiment	0.32	0.92	0.6130	Medium
Control	0.25	0.78	0.5051	Medium

Based on the results of the N-gain test in Table 2, the results of students' creative thinking skills in the experimental class obtained an average N-gain of 0.6130 which was included in the moderate category. While the results of students' creative thinking skills in the control class obtained an average N-gain of 0.5051 which was also included in the moderate category. So based on the results of the N-gain score test calculation, it shows that the average N-gain value for the experimental class is greater than the control class.

**Table 3.** Independent Sample t-test Result

Class	N	Mean	S.D	t	Sig.
Experiment	30	0.6133	0.14411	3.059	0.003
Control	30	0.5047	0.13069	3.059	0.003

Based on Table 3, it can be seen that the  $t_{\text{value}}$  is 3.059. At the significance level  $\alpha = 0.05$ , the significance value obtained is 0.003. In accordance with the decision-making criteria if  $\text{sig} < 0.05$  then  $H_0$  is rejected and  $H_1$  is accepted, this indicates the influence of the PjBL-STEM learning model with design thinking strategies on the creative thinking skills of students of SMAN 2 Pringsewu. The research objective in this study was to determine the effect of PjBL-STEM learning model with design thinking strategy on students' creative thinking ability on the topic of global warming. Based on the results of the study, it was found that students' creative thinking skills on global warming material were still relatively low. The low learning outcomes can be seen from the pre-test results. The results of students' creative thinking skills based on the post-test results in the experimental class and control class have increased. Although the results of students' creative thinking skills in both classes have increased, the results of students' creative thinking skills in the experimental class are higher than the control class. This can be seen from the average post-test value in the experimental class of 82.33 and the average post-test value in the control class of 77.67 with a difference of 4.66.

Based on the results and findings of the study, the application of the PjBL-STEM learning model with a design thinking strategy affects students' creative thinking skills. This shows that the PjBL-STEM learning model with design thinking strategies contributes to the learning process and increases students' understanding of the material taught. This is in line with research conducted by Saefullah [12] that in their research the application of PjBL-STEM can improve creative thinking skills. In this study, there are several factors that influence the high creative thinking ability of students in the experimental class. The experimental class applied the PjBL-STEM learning model with a design thinking strategy. Where the PjBL-STEM model integrates four scientific fields in one learning process, so that learning becomes better in stimulating students' creative thinking skills. Project-Based Learning provides learning that involves students in designing, making, and displaying products to solve real world problems [13]. While the STEM approach involves the integration of science, technology, engineering, and mathematics and other fields of study through Project-Based Learning experiences that require the application of knowledge to solve authentic real world problems in a collaborative environment for the benefit of learners [14], and the design thinking strategy is an approach that focuses on deep understanding of problems and the search for innovative solutions. So that this learning is packaged in the form of project activities, This is what distinguishes between the experimental and control classes.

The learning process in the experimental class begins with the Reflection stage where problems are presented through phenomena such as the increase in the average temperature of the Earth and the melting of polar ice caps as an impact of global warming. As a form of participation in building students' empathy in the empathize stage, the teacher asks students to find solutions to these problems. Learners are asked to investigate the causes of melting polar ice caps and provide solutions to the problems that occur. In this stage, learners are able to recognize countermeasures that become solutions to existing problems. This is supported by [15] which states that the fluency aspect is characterized by students being able to come up with many answers, ideas, problem solving and questions, and students always think of more than one answer. Learners are also trained in flexibility by providing various interpretations in the form of answers to the questions given [15]. So, it can be concluded that at this stage students are able to think creatively on fluency and flexibility indicators.

The next syntax is Research, students are directed to conduct searches related to the factors that cause global warming, looking for relevant information from various literature sources regarding environmental changes as a result of global warming and the largest greenhouse gas emissions that cause global warming. Learners are also directed to find out alternative solutions in tackling greenhouse gas emissions that continue to increase. Learners in groups will be given a project to make solar-powered power banks with the aim of reducing electricity use. This is an application of the design thinking process at the define stage and trains students' creative thinking skills in the fluency indicator, because students are required to analyze problems and find information related to solutions, and design to test the products made.

The next syntax is Discovery. At this stage, students develop a solar-powered powerbank design. Learners determine the tools and materials needed, and draw the product design design. At this stage students also apply the design thinking process at the ideate stage which is seen from their ability to provide ideas or solutions to problem solving in the form of product design. The creative thinking ability that appears at this stage is elaboration which is seen from the ability of students to describe or describe the product they will make. This is in line with research conducted [16] that elaboration is characterized by learners being able to describe tools and materials and provide information on project parts.

The next stage, namely Application at this stage the teacher guides students to start designing solar-powered power banks. Learners make solar-powered powerbank products with their groups and write down the work steps for making products. At the stage of making solar-powered power banks which are carried out in groups, the teacher monitors the activeness of students during project work and monitors students if they experience difficulties. Each learner must be involved and contribute during the manufacturing process. So that students are able to complete the project as planned. Making solar-powered power banks is an application of the prototype stage design thinking strategy, which is characterized by students expressing their ideas in the form of real work, namely making solar-powered power banks as an alternative solution to reduce electricity use (Figure 2). At this stage, students can also produce answers that are presented in their own language which trains their creative thinking skills on their originality indicators. In accordance with the opinion of [17] that originality is the skill of students in solving problems in their own way.



**Figure 2.** Creating Solar Powerbank Products

After the product is finished, students with their groups test the product by directly trying to charge the cellphone. At this stage the creative thinking indicators that are trained are elaboration and originality. The elaboration indicator is seen when learners are able to complete the project according to the specified schedule [18]. Originality is seen when learners are able to complete projects through ideas that have been designed and convey new things obtained. In line with the research of Skinner et al. [19] that involving students in the learning process is important to encourage students to shape STEM learning. Creative thinking skills using STEM-based project learning models are superior to conventional learning models [20].

The last syntax is Communication. At this stage, students make presentations to communicate the results of solar-powered powerbank products that have been made. This final stage is also the last step in the design thinking process, namely the test stage, where students develop, compare, or improve their work. At this stage students practice creative thinking skills on fluency and elaboration indicators. This is supported by [18] that fluency thinking can increase at this stage with the training of students in presentations, students must be able to explain and present project results to other groups. Meanwhile, elaboration can be identified from the way students answer a question in detail and can expand an idea [21].

The findings of this study clearly demonstrate that the implementation of STEM-based Project-Based Learning (PjBL) combined with design thinking strategies has a significant positive effect on students' creative thinking skills in the context of global warming material. The experimental class showed higher post-test scores and N-gain values compared to the control class, with statistical analysis confirming a meaningful difference ( $\text{Sig.} = 0.003 < 0.05$ ). This indicates that the integration of STEM and design thinking into project-based learning provides students with richer opportunities to explore, innovate, and apply knowledge in authentic contexts.

The urgency of these results lies in the fact that creative thinking is one of the core competencies required in the 21<sup>st</sup> century. Traditional teacher centered approaches often fail to stimulate creativity, leaving students passive and disengaged. By contrast, the PjBL-STEM model with design thinking fosters active participation, problem-solving, and innovation. In the context of global warming not only learn scientific concepts but also develop practical solutions, such as designing solar powered power banks. This shows that the model not only enhances cognitive skills but also builds environmental awareness and responsibility.

Scientifically, the impact of this research is twofold. First, it provides empirical evidence that combining STEM integration with design thinking enriches Project-Based Learning outcomes, particularly in creative thinking dimensions such as fluency, flexibility, elaboration, and originality. Second, it contributes to the growing body of literature on innovative pedagogical models that align with the demands of the independent curriculum and global educational trends. The study highlights that creativity can be systematically nurtured through structured learning designs rather than being left to chance.

## 4. Conclusion

Based on the results of research conducted at SMAN 2 Pringsewu, it can be concluded that there is an effect of the PjBL-STEM learning model with a design thinking strategy on students' creative thinking skills on the topic of global warming. This is evidenced by the results of hypothesis testing where the significance value is  $0.003 < 0.05$ . Therefore, this study suggests that teachers can use the PjBL-STEM learning model with design thinking strategies as an alternative in the physics learning process at school. It is also expected for future researchers to be able to provide student activity observation sheets to observe student learning activities during the learning process.

## References

- [1] O. Ađaođlu & M. Demir, 2020. "The integration of 21 st century skills into education: an evaluation based on an activity example," *Journal of Gifted Education and Creativity*, vol. 7, no. 3, hlm. 105–114, 2020.
- [2] Z. Hidayatullah, I. Wilujeng, N. Nurhasanah, T. G. Gusemanto, & Muh. Makhrus, "Synthesis of the 21st Century Skills (4C) Based Physics Education Research In Indonesia," *JIPF (Jurnal Ilmu Pendidikan Fisika)*, vol. 6, no. 1, hlm. 1-10, 2021, doi: 10.26737/jipf.v6i1.1889.

- [3] D M. Sari, M. Ikhsan, Z. Abidin, "The development of learning instruments using the creative problem-solving learning model to improve students' creative thinking skills in mathematics," *Journal of Physics: Conf. Series*, 1088, 012018, 2018, doi: 10.1088/1742-6596/1088/1/012018
- [4] I. Ramadhan, & W. Warneri, "Migrasi Kurikulum: Kurikulum 2013 Menuju Kurikulum Merdeka pada SMA Swasta Kapuas Pontianak". Edukatif: *Jurnal Ilmu Pendidikan*, vol. 5, no. 2, hlm. 751-758, 2023.
- [5] A. R. Puspaningsih, E. Tjahjadarmawan, & N. R. Krisdianti, "Ilmu Pengetahuan Alam Kelas X," Pusat Kurikulum dan Perbukuan, 2021.
- [6] Rusman, "Belajar dan Pembelajaran Berorientasi Standar Proses Pendidikan," Kencana, 2017.
- [7] J. M. Coronado, A. Moyano, V. Romero, R. Ruiz, & J. Rodríguez, "Student Long-Term Perception of Project-Based Learning in Civil Engineering Education: An 18-Year Ex-Post Assessment". *Sustainability*, vol. 13, no. 4, pp. 1-16, 2021, doi: 10.3390/su13041949
- [8] Abdurrahman, F. Ariyani, A. Achmad, & N. Nurulsari, "Designing an Inquiry-based STEM Learning strategy as a Powerful Alternative Solution to Enhance Students' 21<sup>st</sup> -century Skills: A Preliminary Research," *Journal of Physics: Conference Series*, 1155, 012087, 2019, doi: 10.1088/1742-6596/1155/1/012087
- [9] E. Purwaningsih, A. M. Sari, L. Yuliati, K. Masjkur, B. R. Kurniawan, & M. A. Zahiri, "Improving the problem-solving skills through the development of teaching materials with STEM-PjBL (science, technology, engineering, and mathematics-project based learning) model integrated with TPACK (technological pedagogical content knowledge)," *Journal of Physics: Conference Series*, 1481, 012133, 2020, doi: 10.1088/1742-6596/1481/1/012133.
- [10] C.-C. Chang, & W. H. Yen, "The role of learning style in engineering design thinking via project-based STEM course," *Asia Pacific Journal of Education*, vol. 43, no. 3, pp. 1–19, 2021.
- [11] M. P. Hasibuan, R. P. Sari, R. A. Syahputra, & N. Nahadi, "Application of Integrated Project-based and STEM-based E-learning Tools to Improve Students' Creative Thinking and Self-Regulation Skills," *Jurnal Penelitian Pendidikan IPA*, vol. 8, no. 1, hlm. 51–56, 2022, doi: 10.29303/jppipa.v8i1.1050.
- [12] A. Saefullah, A. Suherman, R. T. Utami, G. Antarnusa, D. A. Rostikawati, & Zidny, "Implementation of PjBL-STEM to Improve Students' Creative Thinking Skills On Static Fluid Topic," *JIPF (Jurnal Ilmu Pendidikan Fisika)*, vol. 6, no. 2, pp. 149-157, 2021.
- [13] Sani, R. Abdullah, "Pembelajaran Saintifik untuk Implementasi Kurikulum 2013," Bumi Aksara, 2014.
- [14] B. K. Sandall, L. Darrel, L. Abram & Walton, "Educators' Perceptions of Integrated STEM: A Phenomenological Study," *Journal of STEM Teacher Education*, vol. 53, no. 1, pp. 27–42, 2018.
- [15] L. U. Utami, N. Bukit, M. P. Simanjuntak, & Motlan, "Pengaruh Model Project Based Learning terhadap Keterampilan Berpikir Kreatif pada Materi Fluida Dinamis di SMA," *Jurnal Pendidikan Fisika*, vol. 8, no. 2, hlm. 97–101, 2019.
- [16] Kurniahtunnisa, Y. U. Anggraito, S. Ridlo, & Harahap, "STEM-PjBL Learning: The Impacts on Students' Critical Thinking, Creative Thinking, Communication, and Collaboration Skills," *Jurnal Penelitian Pendidikan IPA*, vol. 1, no. 1, pp. 1-9, 2023.
- [17] A. Samura, "Kemampuan Berpikir Kritis dan Kreatif Matematis melalui Pembelajaran Berbasis Masalah," *MES: Journal of Mathematics and Science*, vol. 5, no. 1, hlm. 20-28, 2019, doi: org /10.30743/mes.v5i1.1934.
- [18] A. Rohman, Ishafit, H. Husna, & K. Kunci, "Pengaruh Penerapan Model Project Based Learning Terintegrasi STEAM terhadap Berpikir Kreatif Ditinjau dari Pemahaman Konsep Fisika Siswa SMA pada Materi Dinamika Rotasi," *Jpft*, vol. 9, no. 1, hlm. 15–21, 2021.

- [19] E. Skinner, E. Saxton, C. Currie, & G. Shusterman, "A motivational Account of the Undergraduate Experience in Science: Brief Measures of Students' Self-System Appraisals, Engagement in Coursework, and Identity as a Scientist. *International Journal of Science Education*, vol. 39, no. 17, pp. 2433-2459, 2017.
- [20] Y. Sukmawijaya, Suhendar, & Juhanda, "Pengaruh Model Pembelajaran STEM-PJBL terhadap Kemampuan Berpikir Kreatif Siswa pada Materi Pencemaran Lingkungan. *Jurnal Program Studi Pendidikan Biologi*, vol. 9, no. 9, hlm. 28-43, 2019.
- [21] Y. Febrianti, Y. Djahir, & S. Fatimah, "Analisis Kemampuan Berpikir Kreatif Peserta Didik dengan Memanfaatkan Lingkungan pada Mata Pelajaran Ekonomi di SMA Negeri 6 Palembang," *Jurnal Profit*, vol. 3, no. 1, pp. 121-127, 2016.