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The Effect of Project-Based Blended Learning Model on Students' Creative Thinking Skills in Global Warming Topic

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Abstract
This paper investigates the effect of project-based blended learning (PBBL) on students' creative thinking skills, particularly in the context of global warming. The research employed a quasi-experimental design using a nonequivalent control group. The study involved 60 students from the 11th grade at SMAN 16 Bandar Lampung. The experiment group with 30 students studied global warming through the PBBL strategy, while the control group used full face-to-face project-based learning (PjBL). The instrument consists of six essay questions. Validity and reliability tests were conducted on the hypothesis test results, indicating significance at a level of less than 5 percent. Using the t-test, a significant difference was observed in the average creative thinking skills between the experiment and control groups. Moreover, the effect size score was 0.785 (high category), confirming the high impact of learning through PBBL. The average n-gain for creative thinking abilities was 0.793 (high) for the experimental class and 0.3791 (moderate) for the control class. It can be inferred that the PBBL model has a positive impact on enhancing students' creative thinking abilities. The research implies that PBBL has the potential to revolutionize traditional teaching methods, fostering students' creative thinking skills, especially when applied to complex global issues like climate change.
Keywords: Blended learning; High school students, Project-based learning (PjBL); Quasi-experiment

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INTRODUCTION

Global warming is one of the environmental issues that has captured global attention and is an indicator of Earth's environmental degradation. Global warming can be described as an ecological disruption marked by an elevation in Earth's average surface temperature. This increase is primarily attributed to the heightened levels of greenhouse gases stemming from human activities (Harmuningsih & Saleky, 2019; Larasati & Juhadi, 2020; Rede, 2016). Knowledge about global

warming is highly important, as it is a global issue that affects our lives and the future of our planet. Understanding the global warming issue helps us become aware of its effects on the environment, ecosystems, and humanity. Consequences of global warming include rising temperatures, shifts in Earth's climate, and the emergence of extreme weather changes.

Awareness regarding global warming is extensive within societies, and pertinent knowledge is easily accessible. However, many individuals still lack sufficient information about effective mitigation measures (National Research Council, 2013). Currently, a portion of the population, particularly students, remains unaware of the personal and societal implications of global warming. They perceive it as a threat, highlighting the need for actions to mitigate its impact (Dombrowski et al., 2016; Ramadhan et al., 2019; Yanti, 2015).

Schools should ideally play a significant role in providing environmental education. However, research indicates that only 47% of students possess substantial knowledge and concern regarding global warming issues (Eksangsri & Jaiwang, 2014). Additionally, matters such as greenhouse gas emissions and global warming are omitted from the curriculum, and teachers tend to evade teaching these topics (Kurup et al., 2015). According to current research, the issue of global warming holds personal importance for most teenagers (Linda et al., 2019).

The results of interviews with physics teachers and students at SMAN 16 Bandar Lampung reveal that students' knowledge, attitudes, and thinking abilities concerning global issues are still relatively low. This situation could be attributed to the COVID-19 pandemic, which has been experienced over the past two years, leading to suboptimal learning experiences for the students. During this period, classroom learning has tended to be passive due to relying on direct instruction. This instructional model is referred to as teacher-centered learning, focusing primarily on the teacher's role. However, this instructional approach is not in line with the characteristics of 21st-century learning, which emphasizes student-centered activities that enable them to actively address the given problems (Khoiri et al., 2016; Puspitarini, 2022).

Today's education must align with the demands of 21st-century learning and the advancements of the digital era. Creative thinking is an essential skill expected to be acquired to adapt to the changes in recent years' globalization era (Gencer & Gonen, 2015; Jules & Sundberg, 2018). This skill corresponds with the competencies emphasized by the 2013 curriculum that are strategically aligned with 21st-century criteria (Henriksen, 2016; Songkram, 2015). Regrettably, within the scope of education, students' creativity levels can still be considered low (Putri et al., 2015). The deficiency in this skill is attributed to the lack of diverse teaching methods to stimulate students' engagement and creativity (Khanifah & Saefan, 2016).

Concerted efforts are required to address this issue in order to enhance the relatively low levels of students' thinking skills. Some approaches that can be undertaken include the development of innovative teaching methods and creating a conducive learning environment. These methods can stimulate the students' independence and creativity, encouraging active participation in the learning process. Fostering a creative learning process is essential for elevating the quality of education. Creativity is a pivotal competence that students need to master (Lu et al., 2021; Wahyuni & Kurniawan, 2018).

One of the suitable instructional models to address the lack of creativity among students is project-based learning (PjBL) (Jumaat et al., 2017). This model is believed to elevate creative thinking

and facilitate students' thinking, enabling them to discover solutions to problems (Desnylasari et al., 2016). According to Noviyana (2017), PjBL is highly applicable within education through problem-solving activities and project creation. This model's conceptual framework allows educators to hone their students' creativity. Ayu et al. (2013) have also argued that the project-based model can enhance the quality of learning.

Blended learning is an instructional approach that can be effectively combined with PjBL (Graham, 2006). Blended learning entails the integration of both traditional face-to-face instruction and e-learning components. The strength of blended learning lies in its accessibility, enabling learning to occur across various locations and timeframes as long as an internet connection is available (Dziuban et al., 2018; Westerlaken, 2019). This approach empowers students to easily communicate, discuss, and solve problems. Even after the formal learning sessions, students can continue interacting with their teachers through the online platforms educators provide. This strategy is widely regarded as a potent tool for achieving higher learning objectives (Dziuban et al., 2018).

The advantages of the project-based blended learning (PBBL) model are very promising. Previous studies have shown that this approach can increase students' active participation, develop their understanding of concepts, and stimulate their creativity and critical thinking skills (Suana et al., 2023). In an online environment, students can interact, collaborate, and design projects with a deeper understanding (Tong et al., 2020). On the other hand, face-to-face sessions allow teachers to provide direct guidance, facilitate group discussions, and provide personal feedback.

However, PBBL also has some disadvantages. Some studies have shown that the PBBL model can present challenges in organizing and optimizing time between online and face-to-face learning. This can impact the overall efficiency and effectiveness of the learning process. In addition, technical barriers, such as uneven internet access among students, must be addressed (Yustina et al., 2020). Furthermore, studies on applying the PBBL model in global warming are still relatively limited. Specifically, at the high school level, opportunities to deeply examine the impact of this approach on improving students' creative thinking skills in understanding and addressing global warming issues have not been explored much. Further research is needed to explore best practices for implementing this approach in different educational contexts, particularly in the context of global warming education at the high school level.

The PjBL is supported by the constructivist learning concept (Hugerat, 2016; Jumaat et al., 2017). The fundamental principle of constructivist theory is to allow learners to employ independent approaches in PjBL. Through this autonomy, learners are trained to think creatively. They can construct knowledge by integrating hands-on exploration in face-to-face learning settings and studying theoretical concepts in facilitated online learning environments (Linda et al., 2019; Shah & Kumar, 2019).

Through the integration of online and offline learning, students can enhance their ability to observe phenomena related to global warming through available instructional videos. Students also utilize discussion columns to interact with teachers or classmates when encountering obstacles in their learning process. The PBBL approach allows students to generate projects, develop ideas, and design solutions. The teacher's role within this learning theory guides the project creation process (Hugerat, 2016).

Based on the description above, the purpose of this study is to investigate the effect of PBBL on students' creative

thinking abilities in physics education, specifically concerning global warming.

METHOD

This quasi-experimental study was conducted at SMAN 16 Bandar Lampung, in Bandar Lampung City, Indonesia. The sample consisted of two groups of 11th-grade students majoring in Science, divided into an experimental group and a control group. Purposive sampling was employed by selecting two groups of students with equivalent abilities from four classes in the school. Each group consisted of 28 students. The research was conducted during the second semester of the 2022/2023 academic year. The study focused on global warming, an imperative topic due to its widespread and significant impact on all nations.

A pre-test was administered to both groups of students before learning treatment was given to collect initial data on students' creative thinking abilities. A post-test was conducted after students completed the instructional treatment. The experimental group received the PBBL, while the control group received the project-blended learning.

The research instrument consisted of a six-item essay test developed by the researchers. The validity test results indicated that all items were considered valid, as evidenced by comparing Pearson correlation values with the critical table value, which was 0.271. Since the Pearson correlation values exceeded 0.271, all items were considered valid. Following the validity assessment, the test's reliability was examined. The results revealed a sufficiently high level of reliability, with a Cronbach's alpha value of 0.71.

Regarding data analysis techniques, the data were analyzed using the t-test, focusing on n-gain, provided that the data met the normal distribution assumption. Additionally, further analysis was conducted using Cohen's.

RESULT AND DISCUSSION

The data concerning students' creative thinking skills in both the experimental and control groups can be found in Table 1 and Table 2. The number of students (N) in both groups in Tables 1 and 2 is the same, totaling 28. The pre-test scores in both groups are almost identical, but there is a notable disparity in their average post-test scores, with the experimental group demonstrating a substantial advantage.

Table 1 Data from the experimental group

Parameter	Pre-test	Post-test
N	28	28
Min.	16.7	75.0
Max.	58.3	100.0
Average	41.1	89.7
STD	12.2	8.7

Table 2 Data of the control group

Parameter	Pre-test	Post-test
N	28	28
Min.	8.3	45.8
Max.	62.5	83.3
Average	40.9	65.0
STD	12.1	9.5

In terms of N-gain, in line with the variations in post-test scores, the N-gain of students in the experimental group is also higher, as shown in Table 3. It appears that the experimental class's N-gain is higher than the control class's N-gain.

Table 3 N-gain of creative thinking skills

Group	N-gain	Category
Experimental	0.78	High
Control	0.40	Moderate

Furthermore, the n-gain data were tested for normality and homogeneity. Normality was tested using the Kolmogrov-Smirnov test, and the results showed that the significance value was greater than 0.05, indicating that the n-gain data were normally distributed. Then, for homogeneity testing using Levene's test, the result was obtained with a sig of 0.134 > 0.05, indicating that the n-gain data had homogeneous variances.

The independent sample t-test results for improving students' creative thinking skills are displayed in Table 4. The data in Table 4 reveals that the significance value is below 0.05. This implies the rejection of the null hypothesis (H_0) and the acceptance of the alternative hypothesis (H_1). In simpler terms, there exists a noteworthy disparity in enhancing creative thinking skills between the experimental and control groups.

Table 4 T-test for n-gain

Levene's Test for Equality of Variance	T-test for Equality of Means
	Sig-2 tailed
	0.000

Following the t-test, an effect size test was conducted. Table 5 displays an effect size of 0.798, categorized as large. This indicates that PBBL substantially impacts the level of creative thinking in the 11th-grade science classes, specifically XI MIPA 2 and XI MIPA 3 of SMAN 16 Bandar Lampung.

Table 5 Effect size test

Class	Mean	Std. Dev.	Effect Size
Experimental	0.78	0.2159	0.798
Control	0.40	0.16682	

This research aims to investigate the effect of PBBL methods on students' creativity skills in the context of global warming. Data for this study was collected through specialized instruments designed to measure and enhance students' creativity skills. The research process involved a pre-test to assess the students' initial levels of competence before the intervention and a post-test to evaluate their progress after the learning intervention. The research subjects consisted of two groups: an experimental group and a control group.

This research applied a PBBL model in the experimental group that integrated online and offline learning methods. On the other hand, the control group received face-to-face instruction using the PBBL model. After completing the learning sessions in both groups, data from the assessments measuring students' creativity skills was collected and processed into average scores.

A comparative analysis between the experimental and control groups was conducted using the N-gain test, documented in Table 3. The data presented in Table 3 indicates that the learning process utilizing the PBBL method in the experimental group was more effective than the conventional PjBL method in the control group. After receiving the intervention, the experimental group achieved an average N-gain score of 0.78, categorizing it as "high". Unfortunately, the control group only achieved an average N-gain score of 0.40 after the intervention, categorizing it as "moderate."

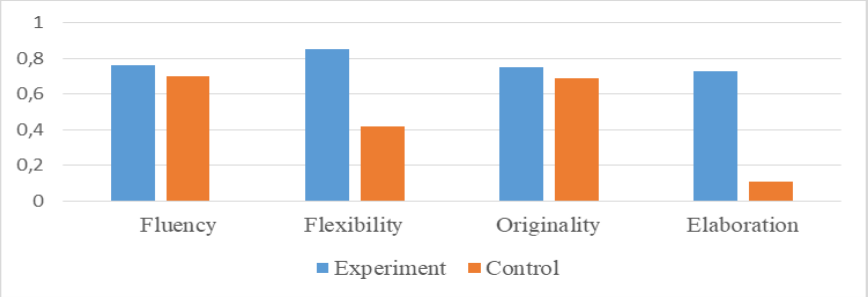

Figure 1 N-gain for each indicator of creative thinking

Both groups were provided with six essay questions as part of the intervention, aiming to assess the increase in creative thinking skills related to global warming. The indicators used in the pretest-posttest essay questions were based on the criteria proposed by Torrance (Khalid et al., 2020). The N-gain data for each creative thinking indicator is shown in

Figure 1. The significant differences observed in the values of both test results, whether in the experimental or control group, are supported by the student's activities during the learning process.

The fluency indicator scored 0.76 in the experimental group, categorized as "high". Meanwhile, in the control group, the fluency indicator received a score of 0.70, also categorized as "high". This indicates that both groups achieved high fluency indicator scores. This improvement occurred because, during the learning process, students were trained to develop their fluency in thinking. As reported by Amtiningsih et al. (2016), activities supporting this improvement included prompting questions, where students could generate ideas and respond to questions quickly.

In the experimental group, the flexibility indicator scored 0.85, categorized as "high" while the control group scored 0.42, categorized as "moderate". The experimental group's improvement occurred because students could construct ideas based on real-world problems and analyze and solve these problems using creative concepts. This finding aligns with the research by Khalid et al. (2020), indicating that students could also categorize real-life issues effectively.

Unlike the control group, the flexibility indicator in the control class received a score of 0.42, categorized as "moderate". The difference in scores occurred because students in the control group could not solve problems using creative ideas. This finding aligns with the research conducted by Indiraningrum (2018), which reported that the flexibility indicator was in the “moderate” category with a 42 percent percentage.

The elaboration indicator scored 0.73 in the experimental group, categorized as "high". Meanwhile, the elaboration indicator scored 0.11 in the control group, categorized as "low". The improvement in the experimental group occurred because students were able to develop aspects of reasoning and flexibility. The achievement of these aspects aligns with the achievement of students' originality in thinking, as mentioned in Amtiningsih et al. (2016). Activities supporting this improvement can be observed in planning students' original project work, as seen in their choice of project tools or media (Ayu et al., 2013).

However, in contrast to the experimental group, the control class obtained an elaboration indicator score of 0.11, categorized as "low". The control class differed because students could not develop reasoning and flexibility. These aspects also correspond to the attainment of students' originality in thinking, as reported by Amtiningsih et al. (2016).

The originality indicator scored 0.75 in the experimental group, categorized as "high". Meanwhile, in the control group, the originality indicator scored 0.69, categorized as "moderate." This difference occurred because students could not fully communicate the details of their project work. This finding aligns with Sumarno's (2010) explanation, which states that students are not yet fully capable of producing creative works in detail.

The explanation regarding the differences in improving N-gain scores for creative thinking indicators between the experimental and control groups suggests that learning with a PBBL approach can enhance students' creative abilities. Contextual factors in creative learning within the PBBL framework are of utmost importance, although differences in student characteristics, teaching approaches, and evaluation methods may lead to varying outcomes (Ulger, 2018). This finding aligns with the research conducted by Agustina and colleagues (2022), which indicates that PjBL with blended learning methods is more effective in improving creative thinking skills than direct instruction.

Using the PBBL model involving the execution of projects such as creating short films, pamphlets, advertising campaigns, and video content falling into the project category has also been proven to enhance students' creative skills. Through these activities, students can construct meaningful and relevant knowledge in real-life contexts. This approach can be considered an adaptation of constructivist theory, providing flexibility for students to construct their understanding of instructional design (Mustafa & Roesdiyanto, 2021).

The PBBL approach has a positive impact on improving students' creative abilities. This is because students can think independently and construct their knowledge through various project activities, as noted by Tong (2020). In this context, students who actively acquire their knowledge tend to have a more meaningful learning experience, aligning with the constructivist learning theory advocated by Irwantoro and Suryana (2016).

Furthermore, the effectiveness of learning activities can be enhanced when students directly engage with the objects of their study, especially those relevant to their immediate environment. Efforts to leverage tools and technology, whether requiring internet access or accessible offline, can also enhance the effectiveness of the learning process (Basar et al., 2021).

Based on the researcher's observations in the experimental class and from online learning activities, the use of the PBBL model has proven to have an optimal impact. Teachers have successfully implemented each stage of the learning process very effectively. Teachers could continue the learning process online even when explaining the material face-to-face was not completed. This facilitated communication between teachers and students before and after the learning sessions. These findings are in line with previous research by Dai et al. (2021) and Tong (2020), which showed that PBBL facilitates communication between teachers and students both before and after the learning sessions.

Students' creative abilities can be enhanced through PjBL (Ayu et al., 2013). Combining a project-based model with blended learning is an effective approach to helping learners achieve learning flexibility by integrating face-to-face and online learning activities into one learning model. This approach also aids learners in discovering their preferences and learning styles (Husamah, 2014).

Effect size testing was also used to measure the extent of the impact of PBBL on students' creative abilities. The researcher used Cohen's calculator to calculate the effect size, resulting in a value of 0.78. This value falls into the high category, within the range of 0.60-0.799. The substantial effect size is due to some students achieving high scores, which influenced the effect size calculation.

However, this research is not without its limitations encountered during its implementation. One major constraint was the limited learning time and school assignments, which made some students reluctant to think about various ways to complete diverse tasks. The multitude of tasks that had to be completed simultaneously made it challenging for some students to focus on the physics tasks assigned. This finding aligns with Farrow et al. (2022), which indicated that constraints in creative thinking often result from limited time, making it difficult for students to complete projects. Nevertheless, through discussions and opportunities for students to enhance their understanding, along with the role of the teacher as a facilitator who coordinates students, students' learning outcomes improved despite the relatively short available time.

The time restrictions found in this study may be lessened in the future by investigating creative time-management

techniques and adaptable instructional methods. Further research on the long-term effects of project-based blended learning (PBBL) on students' capacity for creative thought and its application to other global issues would benefit policymakers and educators.

CONCLUSION

The conclusion drawn from this research is that implementing PBBL has a better positive impact on students' creative thinking skills compared to PjBL on global warming. This is evident from the higher increase in n-gain scores in the experimental group compared to the control group. The experimental group showed an n-gain increase of 0.79, while the control group only had an increase of 0.38. Furthermore, the effect size analysis in this study yielded a value of 0.78. The hypothesis testing results indicated that the difference in the average improvement in creative thinking skills between the group using PBBL and the group using only PjBL is statistically significant at a level lower than five percent.

REFERENCES

Amtiningsih, S., Dwiastuti, S., & Sari, D. P. (2016). Peningkatan kemampuan berpikir kreatif melalui penerapan guided inquiry dipadu brainstorming pada materi pencemaran air. In *Proceeding Biology Education Conference: Biology, Science, Enviromental, and Learning*, 13(1), 868-872.

Ayu, I., Sastrika, K., Sadia, I. W., dan Muderawan, I. W. (2013). Pengaruh model pembelajaran berbasis proyek terhadap pemahaman konsep kimia dan keterampilan berpikir kritis. *E-Journal Program Pascasarjana Universitas*

Dai, N. Van, Trung, V. Q., Tiem, C. Van, Hao, K. P., & Anh, D. T. V. (2021). Project-based teaching in organic chemistry through blended learning model to develop self-study capacity of high school students in Vietnam. *Education Sciences*, *11*(7).

Desnylasari, E., Mulyani, S., & Mulyani, B. (2016). Pengaruh model pembelajaran project based learning dan problem based learning pada materi termokimia terhadap prestasi belajar siswa kelas XI SMA Negeri 1 Karanganyar tahun pelajaran 2015/2016. *Jurnal Pendidikan Kimia*, *5*(1), 134-142.

Dombrowski, E., Rotenberg, L., & Bick, M. (2013). *Theory of knowledge.* Oxford: Oxford University Press.

Dziuban, C., Graham, C. R., Moskal, P. D., Norberg, A., & Sicilia, N. (2018). Blended learning: the new normal and emerging technologies. *International journal of educational technology in Higher education*, *15*, 1-16.

Eksangsri, E., Tippabust, T., & Thanon, J. (2014). Feasibility Study on Reuse of Washed Water in Electronic Industry: Case Study for Flexible Printed Circuit Board Manufacturing in Thailand. *Procedia Environmental Sciences* 20: 206–14.

Farrow, J., Schneider Kavanagh, S., & Samudra, P. (2022). Exploring relationships between professional development and teachers' enactments of project-based learning. *Education Sciences*, *12*(4), 282.

Gencer, A. A., & Gonen, M. (2015). Examination of the effects of reggio emilia based projects on preschool children's creative thinking skills. *Procedia - Social and Behavioral Sciences*. 186, 456–460.

Graham, C. R. (2006). Sistem pembelajaran campuran: Definisi, tren saat ini, dan arah masa depan. Dalam CJ Bonk & CR Graham (Eds.), The handbook of blended learning: Perspektif global, desain lokal (hlm. 3–21). San Fransisco: Pfeiffer.

Gül, A., Topay, M., & Özaydÿn, O (2009). Terhadap ancaman

pemanasan global, pentingnya hutan kota. Makalah yang dipresentasikan pada Kongres Internasional Davraz, Isparta, Türkiye.

Filsaime, D. K. (2018). *Menguak rahasia berfikir kritis dan kreatif*. Jakarta: Prestasi Pustakarya.

Harmuningsih, D., & Saleky, S. R. J. (2019). Pengetahuan, persepsi dan sikap generasi muda tentang perubahan iklim dan pengaruhnya terhadap niat perilaku pro-lingkungan. *SPECTA Journal of Technology*, *1*(3), 27–36.

Henriksen, D., Mishra, P., & Fisser, P. (2016). Infusing creativity and technology in 21st century education: A systemic view for change. *Journal of Educational Technology & Society*, *19*(3), 27-37.

Hugerat, M. (2016). How teaching science using project-based learning strategies affects the classroom learning environment. *Learning Environments Research*, *19*(3), 383-395.

Husamah, H. (2014). *Pembelajaran bauran (blended learning)*. Jakarta: Prestasi Pustaka Jaya.

Irwanto, N., & Suryana, Y. (2016). Kompetensi Pedagogik untuk Peningkatan dan Penilaian kinerja guru dalam rangka implementasi kurikulum nasional. *Sidoarjo: Genta Group Production*.

Jules, T. D., & Sundberg, K. C. (2018). The internationalization of creativity as a learning competence. *Global Education Review*, *5*(1).

Jumaat, N. F., Tasir, Z., Halim, N. D. A., & Ashari, Z. M. (2017). Project-based learning from constructivism point of view. *Advanced Science Letters*, *23*(8), 7904-7906.

Khalid, M., Saad, S., Abdul, H. S. R., Ridhuan, A. M., Ibrahim, H., & Shahrill, M. (2020). Enhancing creativity and problem solving skills through creative problem solving in teaching mathematics. *Creativity Studies*, *13*(2), 270–291.

Khanifah, K., & Saefan, J. (2016). Pengaruh model project based learning melalui metode praktikum terhadap kecakapan kreativitas pada materi getaran harmonis siswa kelas xi mia sma negeri 1 comal. *Jurnal Penelitian Pembelajaran Fisika*, 7(1), 49–55.

Khoiri, N., Marinia, A., & Kurniawan, W. (2016). Keefektifan model pembelajaran PjBL (Project Based Learning) terhadap kemampuan kreativitas dan hasil belajar siswa kelas xi. *Jurnal Penelitian Pembelajaran Fisika*, 7, 142–146.

Kurup, P. M., Cox, P., & Deed, C. (2015). Building primary pre-service teachers' confidence and competence to teach science: The effect of planning, teaching and reflecting on an integrated science unit. Journal of Academic Perspectives, 8(2), 1-16.

Lu, K., Yang, H. H., Shi, Y., & Wang, X. (2021). Examining the key influencing factors on college students' higher-order thinking skills in the smart classroom environment. *International Journal of Educational Technology in Higher Education*, *18*, 1-13.

Larasati, F., & Geografi, J. (2020). Tingkat literasi sains global warming terhadap sustainable lefestyles guru sekolah dasar di desa bangsri kabupaten jepara. *Edu Geo*, *8*(2), 113–120.

Linda, R. F. C., Widodo, S., Karimah, N., & Ngazizah, N. (2019). Penerapan project based learning pada praktikum mahasiswa pgsd semester 2 untuk meningkatkan kreativitas dan pemecahan masalah. *Kolokium Penelitian Universitas*, 214–222.

Limbong, R. (2021). Isu pemanasan global pada pergeseran paradigma studi keamanan dalam hubungan internasional. *Jurnal Diplomasi Pertahanan*, *7*(1).

Mustafa, P. S. & Roesdiyanto, R. (2021). Penerapan teori belajar

konstruktivisme melalui model PAKEM dalam permainan bolavoli pada sekolah menengah pertama. *Jendela Olahraga*, 6(1), 50–65.

National Research Council. (2013). *Monitoring progress toward successful K-12 STEM education: A nation advancing?*. National Academies Press.

Noviyana, H. (2017). Pengaruh model project-based learning terhadap kecakapan kreativitas matematika siswa. *Jurnal Edumath*, *3*(2), 110-117.

OECD (2016), Innovating education and educating for innovation: the power of digital technologies and skills. OECD Publishing, Paris

Putri, L. T., Nuroso, H., & Khoiri, N. (2015). Efektivitas model pembelajaran berbasis proyek (project based learning) terhadap keaktifan dan kecakapan kreativitas siswa kelas x sma n 2 semarang. *Jurnal Penelitian Pembelajaran Fisika*, 6(2), 38–43.

Puspitarini, D. (2022). Blended learning sebagai model pembelajaran abad 21. *Ideguru: Jurnal Karya Ilmiah Guru*, *7*(1), 1–6.

Ramadhan, S., Sukma, E., & Indriyani, V. (2019). Environmental education and disaster mitigation through language learning. *IOP Conference Series: Earth and Environmental Science*, *314*(1).

Ratnasari, R., Susatyo, E. B., & Nurhayati, S. (2017). Pengaruh pembelajaran berbasis proyek berbantuan lembar kerja siswa terhadap kemampuan berpikir kreatif. *Chemistry in Education*, *6*(2), 1-7.

Rede, A. (2010). Pembelajaran tematik pemanasan global dan kesadaran diri siswa sekolah dasar. *Jurnal Ilmu Pendidikan Universitas Negeri Malang*, *17*(3), 105155.

Rodiyana. (2013). Penerapan strategi pembelajaran inkuiri terhadap kemampuan berpikir kritis dan kretaif siswa. *Jurnal Pembelajaran Fisika*, 1(2): 20-25.

Shah, S., & Kumar, R. (2019). Effective constructivist teaching learning in the classroom. Shah, RK (2019). Effective Constructivist Teaching Learning in the Classroom. *Shanlax International Journal of Education*, 7(4), 1-13.

Songkram, N. (2015). E-learning system in virtual learning environment to develop creative thinking for learners in higher education. *Procedia - Social and Behavioral Sciences*. 174 (1), 674-679.

Tong, Y., & Wei, X. (2020). Teaching design and practice of a project-based blended learning model. *International Journal of Mobile and Blended Learning (IJMBL)*, *12*(1), 33-50.

Ulger, K. (2018). The effect of problem-based learning on the creative thinking and critical thinking disposition of students in visual arts education. *Interdisciplinary Journal of Problem-Based Learning*, *12*(1).

Wahyuni, A., & Kurniawan, P. (2018). Hubungan kemampuan berpikir kreatif terhadap hasil belajar mahasiswa. *Matematika: Jurnal Teori dan Terapan Matematika*, *17*(2), 1-8.

Westerlaken, M., Christiaans-Dingelhoff, I., Filius, R. M., De Vries, B., De Bruijne, M., & Van Dam, M. (2019). Blended learning for postgraduates; an interactive experience. *BMC medical education*, *19*(1), 1-7.

Yanti, W. A. (2015). Persepsi siswa smp kelas 7 terhadap konsep pemanasan global. *Prosiding Seminar Nasional Fisika (E-Journal) SNF 2015*, *IV*, 1–4.