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The Effectiveness of the Project Based Learning (PjBL) Model on the Creative Thinking Skill of Students in the Human Respiration System

Yenny Anwar[1*], Dinda Nurfadhilah[1], Masgus Tibrani[1]

[1] Biology Education, Faculty of Teacher Training and Education, Universitas Sriwijaya, Palembang, Indonesia.

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Corresponding Author:
Yenny Anwar
yenny_anwar@fkip.unsri.ac.id

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Abstract: This study aims to determine the effectiveness of the Project Based Learning (PjBL) learning model on student's creative thinking skill on the topic of the human respiratory system. This research is an experimental research using Quasi Experimental Method with Nonequivalent Control Group Design. Data management uses SPSS 25. The results showed that the application of the Project based Learning model (PjBL) increased students' creative thinking skills with a gain of 47.4 and n-gain of 0.67 in the medium category. The results of the analysis of hypothesis testing show the value of Sig. 0.000 < 0.05 so that H1 is accepted. After the effect size test was carried out, a value of 1.15 was obtained in the large category besides that student responses have a good and process and product assessment has a very creative category. This indicates that the application of the Project based learning model has a significant effect on students' creative thinking skill on the topic of the human respiratory system.

Keywords: Creative thinking skill; Learning model; PjBL; Respiration system

Introduction

Education in the 21st century educators are required to empower higher order thinking skills and see all problems from various perspectives so that they can solve problems more efficiently (Anwar et al., 2020). The high demands of the 21st century lead to learning that provides students with various skill, including the 4C, namely Communication, Collaboration, Critical Thinking and Problem solving, and Creative and Innovative (Putra et al., 2019; Siagian, 2022; Thornhill-Miller et al., 2023). Critical and creative thinking skills are part of the generic thinking skills that must be developed in student competencies (Anwar et al., 2020; Liang et al., 2021; Virtanen et al., 2019). The results of Programme for International Student Asssessment (PISA) 2018 released by OECD (Organization for Economic Cooperation and Development), Indonesia ranked 74th out of 79 participating countries. The average science score obtained by Indonesian students reached 389, with an OECD average score of 489 (Tohir, 2019). The lack of high-level thinking skills of students, especially in one of the 4C components, namely Creative and Innovative, which is still low due to the low learning activities of students, especially in learning biology, most students still rely on memorization skills, with learning models that do not facilitate exploring ideas on the problems faced, especially in the human respiration system, which discusses the process of complex mechanisms and involves various organs in carrying out their functions (Nurjamilah et al., 2020).

To maximize student skills, the 2013 curriculum and the independent curriculum direct learning models that support the scientific learning process, one of which is the project-based learning mode in line with Wahyu et al. (2018) opinion that one of the learning models that supports Curriculum 13 is Project Based Learning Model (PjBL)

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The phases of the project-based learning model developed by The George Lucas Educational Foundation (2005) are asking essential questions, designing a project plan, preparing a schedule of activities, monitoring students' activities, assessing students' success, and evaluating students' experiences. These six phases are thought to be able to train students' creative thinking skill. Using project-based learning is expected to improve students' creative thinking skills, and project-based learning has enormous potential to train students' thinking processes that lead to students' creative thinking skills (Insani et al., 2015).

So the researcher is interested in conducting research with the title: The Effectiveness of Project Based Learning Model on Students' Creative Thinking Ability on the Topic of Human Respiration System.

Method

The research method used in this research is Quasi Experimental with the form of Nonequivalent Control Group Design, namely the application of pretest before treatment so that it can be compared with the treatment results and get more precise results.

Table 1. Research Design

Group	Pretest	Treatment	Posttest
Experiment	P1	X	P2
Control	P3	C	P4

Information:
P1 : Pre-test in the experimental class
P2 : Post-test in the experimental class
P3 : Pre-test in the control class
P4 : Post-test in the control class
X : Project Based Learning Method
C : Conventional Method

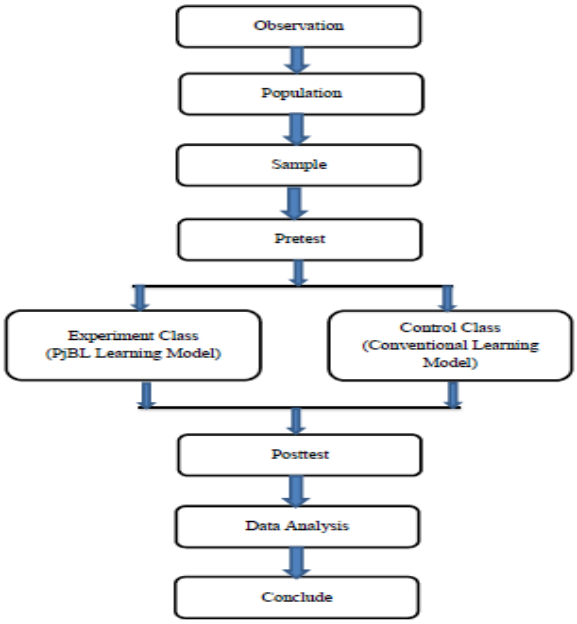

Figure 1. Research Flow Chart

There are 3 stages of research, namely the preparation, implementation, and completion stages. In the preparation stage, researchers conducted preliminary studies, observations, determined the population and samples, compiled lesson plans, compiled research instruments in the form of Pretest questions and posttest questions, observation sheets, and questionnaires, prepared student worksheets on Project Based Learning model learning. In the implementation stage of applying the Project Based Learning model, the first step is to conduct a pre-test, then give the Project Based Learning model treatment in the experimental class, and the conventional learning model in the control class. After that, do the posttest. At this stage, researchers process and analyze data, test hypotheses, draw conclusions, and report research results.

Result and Discussion

The results of this study aim to determine the effectiveness of the application of project-based learning models (PjBL) on students' creative thinking skills. Creative thinking skill has four indicators: fluency, flexibility, originality, and detail (Munandar, 2014). Creative thinking skills are measured using description questions as well as process and product assessments.

Project Based Learning integrates knowledge into the direct experience of students by prioritizing the development of thinking skills, therefore, the Project Based Learning model was chosen as an effort to improve students' creative thinking skills (Chang et al., 2022; Fadhil et al., 2021; Prihatin, 2021).

The application of the PjBL model was obtained with an observation sheet through the assessment of students' activities, as well as the use of a questionnaire to get students' responses to the PjBL model, consisting of 10 positive questions and 10 negative questions. The following are the results of the research that has been done.

Table 2. Average Initial Test Scores, Final Tests and Gains in Creative Thinking Skills of Students with the PjBL Model in the Experimental Class

Creative Thinking Skill	Pre-Test	Post-Test	Gain	N-Gain	N-Gain Category
Fluency	31.03	66.38	35.35	0.51	Moderate
Flexibility	40.23	86.49	46.26	0.77	High
Originality	19.54	66.38	46.84	0.58	Moderate
Elaboration	22.41	84.91	62.5	0.81	High
Average	28.30	76.04	47.74	0.67	Moderate

Based on table 2 analysis of test results in the experimental class, the average posttest value of students' creative thinking has increased in all indicators, compared to the average pretest value, with an average pretest value of 28.30 and an average posttest value of 76.04 so it can be said that the test results of creative thinking questions in the experimental class after learning treatment with the PjBL model have increased by 0.67 in the moderate category. This research is in line with research conducted by Sari et al. (2019) that through the gain test, there is a difference between the PjBL and conventional models with a moderate category.

Table 3. Average Initial Test Scores, Final Tests and Gains in Creative Thinking Skills of Students with the PjBL Model in the Control Class

Creative Thinking Skill	Pre-Test	Post-Test	Gain	N-Gain	N-Gain Category
Fluency	35.83	66.67	30.84	0.48	Moderate
Flexibility	56.67	78.61	21.94	0.51	Moderate
Originality	29.72	63.33	33.61	0.48	Moderate
Elaboration	35.42	67.5	32.08	0.49	Moderate
Average	39.41	69.03	29.62	0.49	Moderate

Based on the table 3 analysis of test results in the control class, the average posttest value of students' creative thinking has increased in all indicators, with an average pretest value of 39.41 and an average posttest value of 69.03 so it can be said that the test results of creative thinking questions in the control class have increased by 0.49 with a moderate category. That way, it can be seen that the creative thinking ability of the experimental class has increased more than the control class.

The following is a diagram of the comparison of the increase in N-Gain values in the experimental and control classes.

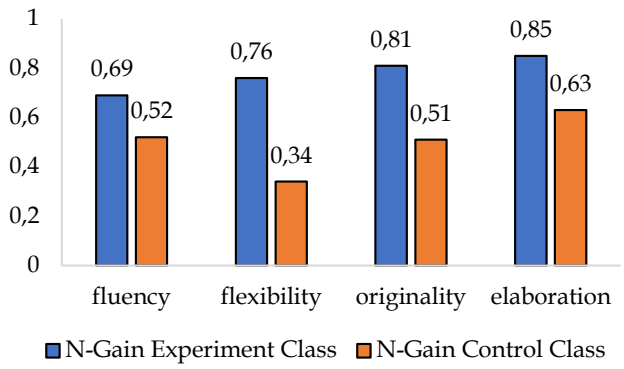

Figure 2. N-Gain comparison of creative thinking skills

Based on the Figure 1 diagram, the highest N-Gain value of the experimental class is in the detailing indicator, which is 0.81 with a high category, while the control class has an N-Gain value of 0.49 with a medium category. Furthermore, for the lowest N-Gain value on the fluent indicator with an experimental class N-Gain of 0.51 and a control class N-Gain of 0.48 in the moderate category, it can be concluded that the experimental class is higher in all indicators than the control class N-Gain.

The following is a diagram of the category of mastery of creative thinking skills for each learner.

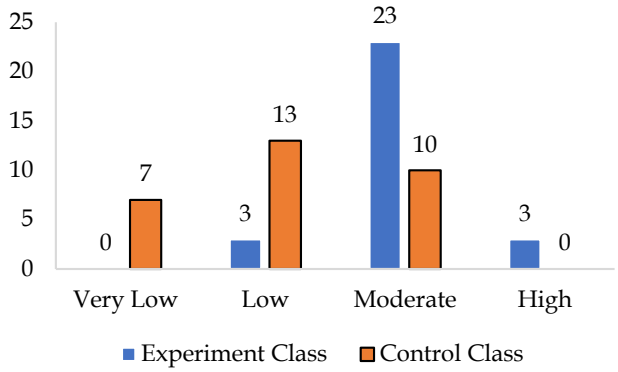

Figure 3. Categories of mastery of creative thinking skills

Figure 2 shows the mastery of students' creative thinking skills with the highest category in the experimental class, namely the moderate category of 23 students, and the highest category in the control class, namely the low category with 13 students. It can be concluded that the skill of students in the experimental class using the PjBL learning model is better, with most of the students' creative thinking skills in the moderate

category, while in the control class most of the students' creative thinking skills are in the low category.

Syntax 1 Start with essential question, at this stage each group of students is given a worksheet. Learners listen to the researcher's explanation of the topic of the respiration system and the procedures for working on worksheet. After answering questions related to respiration system material, students are directed to watch videos related to the impact of air pollution on health problems in the respiration system, from the video each group is asked to discuss and give opinions on the video, identify problems, and then answer basic questions given by researchers in the form of solutions that can be done so that the dangers of air pollution are known to the public. In this activity, students are encouraged to develop thinking power as an effort to answer the question. At this stage students give many opinions and solutions to problems, which is supported by research Rafik et al. (2022) which states that this stage helps learners think creatively, especially in the indicators of thinking fluently and flexibly. Questions are the gateway to learners' thinking. For learners, skilled educators intentionally design and ask questions that are appropriate for each learning objective so that children will better understand concepts and act intelligently (Salmon et al., 2021).

Syntax 2 Design a plan for the project, at this stage learners determine the steps of the project, seek information by accessing the internet to get references in project planning, by working together to get information, images, and determine the theme and color of the poster to be made. Several studies have shown that collaboration and electronic communication can positively influence creativity, including the creative performance of secondary school students in design (Bereczki et al., 2021). Activities at this stage support the creative thinking skills of students on the indicators of thinking fluently, flexibly, and originality, this is supported by research (Davies et al., 2013), it is mentioned that in the context of learning activities that involve making art and design or design and technology there is strong evidence across a number of studies that providing an appropriate range of materials, tools, and other resources can stimulate creativity.

Syntax 3 Create schedule. Researchers and students determine the deadline for collecting assignments, as well as prepare a timeline according to the discussion of each group. At this stage, it can train students' creative thinking skills, especially on the indicator of fluent thinking (Surya et al., 2021). This can be seen from the timeliness of working on projects that indicate the skill of learners to think fluently. Fluent thinking refers to the ability of individuals to change thinking paths when they encounter dead ends or thinking obstacles or to generate different types of ideas. (Suherman et al., 2022).

Syntax 4 Monitoring the student and progress of the project (monitoring students and the progress of the project) monitors by asking the progress of the project made then the researcher provides direction to students against the obstacles experienced by each group, from this activity the ability of students to increase the capacity of students to respond to situations in unusual ways which is the essence of creativity (Henriksen et al. 2020), at this stage the ability of learners to improvise to complete the project is seen such as determining the editing application that is tailored to the skill of group members, improvisation ability is a form of creativity as described in the research (Poutiainen, 2012). Improvisation teaches negotiating with personal and collective goals.

Syntax 5 Assess the outcome, each group presents the results of the project work and expresses the community's response to the product they made as described in the study (Rafik et al., 2022) this activity trains learners in delivering project results (fluent thinking), providing arguments for project work (flexible thinking), and strengthening ideas (elaboration). This is supported by research (Kim et al., 2022) who said that creative ideas depend on cognitive flexibility, cognitive flexibility plays an important role in experience and two indices of creative potential namely, fluency and flexibility.

Syntax 6 Evaluation the experience. Some factors that influence creative performance include personality and work environment. Self-efficacy, creative identity, creative mindset, and metacognition play a role in the decision to complete or not complete a creative task (Doss et al., 2023; Lebuda et al., 2023; Zielińska et al., 2022). Therefore, by evaluating the experience, students express their opinions about their experiences during project work, about the cooperation of group members, the difficulties faced, and the benefits gained from the learning that has been followed. At this stage, a reflection will be carried out regarding the learning process that has been carried out, so that at this stage it can train students' creative thinking skills on the elaboration indicator (Wahida et al. 2015).

Analysis of the results of the normality test obtained through the value of the students' creative thinking skill test data using the help of the SPSS 25 application. Can be seen in the following table.

Table 4. Normality Test

Tests of Normality

	Class	Kolmogorov-Smirnova			Shapiro-Wilk		
		Statistic	Df	Sig.	Statistic	Df	Sig.
N-Gain of Student Learning Outcomes	Experiment	.12	29	.20*	.97	29	.54
	Control	.15	30	.06	.94	30	.12

*. This is a lower bound of the true significance.
a. Lilliefors Significance Correction

Based on table 4, the analysis of the normality test results of the students' test data shows that the significance level obtained is 0.200 in the experimental class which is greater than 0.05, then the data is normally distributed and 0.064 in the control class, which is greater than 0.05, then the data is normally distributed.

The homogeneity test aims to determine whether a variation in experimental class posttest data (PjBL) and control class posttest data is homogeneous (the same) or heterogeneous (not the same).

Table 5. Homogeneity Test

Test of Homogeneity of Variance

		Levene Statistic	df1	df2	Sig.
Students' Pre-test Results	Based on Mean	.04	1	57	.85
	Based on Median	.03	1	57	.88
	Based on Median and with adjusted df	.03	1	52.23	.88
	Based on trimmed mean	.04	1	57	.84

Based on table 5, the homogeneity test proves that the pretest data from the two groups measured are homogeneous. Based on the output above, it is known that the significance value (Sig) Based on Mean is 0.840> 0.05. So it can be concluded that the variance of experimental class data and data is homogeneous or the same.

Hypothesis testing using the Independent Sample T Test. The results of the hypothesis test are shown in table 6.

Table 6. T Test

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	Upper
Learners' test results	Equal variances assumed	4.87	.03	6.63	57	.00	19.73	2.98	13.77	25.69
	Equal variances not assumed			6.69	47.09	.00	19.73	2.95	13.79	25.67

Based on table 6, it is known that the variance of the experimental and control class data is homogeneous, so the t-test is guided by the Sig. value found in the Equal variances assumed table. Based on the table above, it is known that the Sig. (2-tailed) is 0.000 <0.05. So that H0 is rejected and H1 is accepted that the application of the Project Based Learning (PjBL) model has a significant effect on students' creative thinking on the topic of the human respiration system.

This effectiveness test aims to determine the magnitude of the effect of using the PjBL model on the creativity of students. This test is carried out after there are hypothesis test results that prove that the hypothesis is accepted and the t-test is significant.

Table 7. Effect Size Test

Description	Experiment Class	Control Class
Mean	66.23	46.50
Standard Deviation	7.99	13.66
SD Pooled		16.62
Cohen's d		1.15
Effect Size Category		Great

Based on table 7, the effect size value is 1.15 with a large category. That way the test results of students have

an effect size value with a large category with the application of PjBL learning.

Observation of learning implementation was carried out with the aim of measuring the percentage of implementation of stages in the learning process using PjBL syntax. The results of the analysis of the implementation of the PjBL learning process can be seen in the following table.

Table 8. Learning Implementation Results

Activities	Value of Meeting-		
	1	2	3
Introduction	100	100	100
Core	100	100	100
Conclusion	100	100	100
Average	100	100	100
Category	100% (Very Good)		

Based on Table 8, the results of implementation are very good and the average percentage value is 100%. This shows that learning using PjBL follows the plan contained in the lesson plan.

Table 9. Learner Activity

Activities	Value of Meeting-			Average	Category
	1	2	3		
Introduction	95.7	83	100	92.9	Very Good
Core	100	100	100	100	Very Good
Conclusion	75	66.5	100	80.5	Very Good
Average					96.7 (Very Good)

Student activity data aims to measure student activity during the learning process according to the stages of the PjBL model. The average learner activity can be seen in table 9. Based on Table 9, it shows that the learning implementation activities of students using the PjBL model with an average value of 96.7% are in the very good category. Product analysis is carried out to measure the level of creativity of students in the products produced. The following are the results of the process and product analysis.

Table 10. Process and Product Assessment

Group	Percentage (%)	Category
1	87.5	Very Creative
2	87.5	Very Creative
3	87.5	Very Creative
4	95.8	Very Creative
5	87.5	Very Creative
6	83.3	Very Creative

Based on table 10, the products produced by each group are in the very creative category with a score range of 83.3% - 95.8%.

Table 11. Percentage of Process and Product Indicators

Creative Thinking Skill	Percentage (%)
fluency	88.9
flexibility	86.1
originality	83.3
elaboration	94.4

From table 11, it can be said that the highest indicator is detailing with a score of 94.4 and the lowest original indicator with a score of 83.3.

The first indicator, namely fluency (ability to think fluently) consists of 2 aspects, including the ability of students to plan products and the timeliness of product completion. In the fluent thinking indicator, a percentage of 88.9% was obtained in the very creative category, because in each group most students had done the aspects measured well. In accordance with research conducted by Nur et al. (2018) which explains that project-based learning is better at improving students' fluent thinking aspects. PjBL integration is effective in improving students' critical and creative thinking skills (Astriani et al., 2023; Hasibuan et al., 2022; Iskandar et al., 2022; Maor et al., 2023).

The second indicator is flexibility (ability to think flexibly), consisting of 2 aspects, including the ability of students to select socialization media and ease of product access. In the flexible thinking indicator, a percentage of 86.1% was obtained in the very creative category, students chose Instagram socialization media according to the digital poster products made but some groups socialized posters on accounts with privacy settings (private) so that it was quite difficult to be accessed by the wider community. The results of the assessment of the ability to think flexibly are in accordance with research Surya et al. (2012) which states that the ability to think flexibly has many alternative problem solving, and is able to change the way of approaching and thinking.

The third indicator, namely originality, consists of 2 aspects, including product novelty and product suitability and utilization. In the original thinking indicator, a percentage of 83.3% was obtained in the very creative category, the original indicator is the lowest indicator among other indicators, it can be seen that the products made by students are almost the same as existing products, this shows that students still cannot add novelty to existing products. This is in line with research conducted by Luthvitasari et al. (2012) who concluded from their research that this happens because children still have limited imagination and innovation capacity.

The fourth indicator, namely elaboration, consists of 2 aspects, including the ability to design products and the physical form of products such as adding pictures, colors, and details to the product. In the indicator of

detailed thinking, a percentage of 94.4% was obtained in the very creative category, this indicator is the indicator with the highest score, it can be seen that students are creative in adding pictures, colors, details, and containing structured information on the product. This is in accordance with research conducted by Ayu et al. (2019) which states that detailed thinking skill is the highest creative thinking skill.

To find out the response of students to learning using the PJBL model. Data analysis of students' responses can be seen in table 12.

Table 12. Analysis of Learner Response Questionnaire

Question	Percentage (%)	Category
Defining the Project	76	Good
Design the steps to complete the project	78	Good
Develop a project implementation schedule	74	Good
Completing the project with teacher's facilities and monitoring	77	Good
Prepare a report and presentation or publication of project results	80	Good
Evaluate the project process and results	72	Good

Based on table 12, the average category of students' responses to learning using the PjBL model as a whole gets a 100% good category, it means that students respond well to the learning process to measure creative thinking skills using the PjBL model.

Based on the discussion of the results of the research that has been done, it shows that the application of the Project Based Learning (PjBL) model is effective on the creative thinking skills of students on the material of the human respiratory system. Its because of the syntax of the project-based learning method be able to assist students in optimizing their creative and critical mindsets by starting learning with essential questions, working together to plan, developing project completion schedules, timelines, and deadlines. This is in line with research conducted (Khoiri et al., 2016; Pan et al., 2023; Zulyusri et al., 2023) which states that based on the results of the analysis carried out, the PjBL model is effective on the creativity of students. Therefore, teachers are expected often be applied PjBL in the learning process. Teachers should be able to better understand cognitively, affectively and psychomotor in students' minds and possibly improve students' creative thinking skills on each dimension of creativity (Leasa et al., 2023).

Conclusion

The application of Project Based Learning model (PjBL) has a significant effect on students' creative thinking skills, seen from the hypothesis test analysis indicating a significance of 0.000<0.05, the results of gain and n_gain analysis as well as tests and student creativity products in the experimental class also indicate an increasing in low to medium category. This shows a change in students' thinking abilities in a more positive direction. This is also supported by the results of the observation analysis of learning implementation which was carried out in the very good category and the results of the effect size test obtained a value of 1.15 in the large category so that the PjBL model is effectively used in improving students' creative thinking skill on the topic of the human respiratory system.

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Author Contributions

All authors in this article contributed to the process of completing the research. A, Y directed the research flow, validated collection instruments, methodology, analyze data, reviewed articles. Dinda N, D taking initial research data, processing the data, writing draft articles, T, M validated, refined results and discussion.

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Conflicts of Interest

In this study all authors do not have a conflict of interest, because this research is an independent research in which all funds spent during the research process use the researcher's personal funds. There are no other interests in this research, but researchers only want to contribute to advancing education by informing the findings in this research. So that it can provide more benefits to the reader.

References

Anwar, Y., Selamet, A., Huzaifah, S., & Madang, K. (2020). Training in developing higher-order thinking based online test instrument for biology teachers in Sekayu City. *Journal of Community Service and Empowerment*, *1*(3), 150–155. https://doi.org/10.22219/jcse.v1i3.12241

Astriani, D., Martini, Rosdiana, L., Fauziah, A. N. M., & Purnomo, A. R. (2023). STEAM-Project Based Learning (PjBL): Efforts to Train Critical Thinking Skills for Prospective Science Teacher. *Jurnal Penelitian Pendidikan IPA*, *9*(10), 7909–7915. https://doi.org/10.29303/jppipa.v9i10.3823

Bereczki, O., & Andrea, K. (2021). Technology-enhanced creativity : A multiple case study of digital technology-integration expert teachers ' beliefs and practices Enik o. *Thinking Skills and Creativity*, *39*(January). https://doi.org/10.1016/j.tsc.2021.100791

Candra, R. A., Prasetya, A. T., & Hartati, R. (2019). Analisis kemampuan berpikir kreatif peserta didik melalui penerapan blended project-based learning. *Jurnal Inovasi Pendidikan Kimia*, *13*, 2437–2446. https://doi.org/10.15294/jipk.v13i2.19562

Chang, T.-S., Wang, H.-C., Haynes, A. M., Song, M.-M., Lai, S.-Y., & Hsieh, S.-H. (2022). Enhancing student creativity through an interdisciplinary, project-oriented problem-based learning undergraduate curriculum. *Thinking Skills and Creativity*, *46*, 101173. https://doi.org/10.1016/j.tsc.2022.101173

Davies, D., Jindal-snape, D., Collier, C., Digby, R., Hay, P., & Howe, A. (2013). Creative learning environments in education - A systematic literature review. *Thinking Skills and Creativity*, *8*, 80–91. https://doi.org/10.1016/j.tsc.2012.07.004

Doss, K., & Bloom, L. (2023). Mindset and the desire for feedback during creative tasks. *Journal of Creativity*, *33*(1), 100047. https://doi.org/10.1016/j.yjoc.2023.100047

Fadhil, M., Kasli, E., Halim, A., Evendi, Mursal, & Yusrizal. (2021). Impact of Project Based Learning on Creative Thinking Skills and Student Learning Outcomes. *Journal of Physics: Conference Series*, *1940*(1), 012114. https://doi.org/10.1088/1742-6596/1940/1/012114

Fajrina, R. N. A. A., Handayanto, K. S., & Hidayat, A. (2018). Peran Model Project Based Learning dalam Kemampuan Berpikir Kreatif Kelas XI IPA melalui Materi Fluida Statis. *Jurnal Pendidikan*, *3*(3), 291–295. Retrieved from http://journal.um.ac.id/index.php/jptpp/

Hasibuan, M. P., Sari, R. P., Syahputra, R. A., & Nahadi, N. (2022). Application of Integrated Project-based and STEM-based E-learning Tools to Improve Students' Creative Thinking and Self-Regulation Skills. *Jurnal Penelitian Pendidikan IPA*, *8*(1), 51–56. https://doi.org/10.29303/jppipa.v8i1.1050

Henriksen, D., Richardson, C., & Shack, K. (2020). Mindfulness and creativity : Implications for thinking and learning. *Thinking Skills and Creativity*, *37*(August), 1–10. https://doi.org/10.1016/j.tsc.2020.100689

Insani, H., Zaputra, R., & Mariana. (2015). Pengaruh pembelajaran berbasis proyek terhadap kemampuan berpikir kreatif siswa pada materi sistem pencernaan manusia kelas VIII SMPN 6 Pekanbaru T.A. 2014/2015. *Prosiding Seminar Nasional III Biologi Dan Pembelajarannya Universitas Negeri Medan*, *50*. Retrieved from http://digilib.unimed.ac.id/28392/2/H Insani%2C R Zaputra%2C Mariana.pdf

Iskandar, I. Z., Sulastri, S., Saminan, S., Elisa, E., Yusrizal, Y., Khaldun, I., & Hanum, L. (2022). Implementation of Project Based Learning Through the STEMC Approach to Improve Students' Creative Thinking Skills. *Jurnal Penelitian Pendidikan IPA*, *8*(3), 1389–1392. https://doi.org/10.29303/jppipa.v8i3.1585

Khoiri, N., Marinia, A., & Kurniawan, W. (2016). Keefektifan model pembelajaran PjBL (Project Based Learning) terhadap kemampuan kreativitas dan hasil. *Jurnal Penelitian Pembelajaran Fisika*, *7*, 142–146. Retrieved from http://journal.upgris.ac.id/index.php/JP2F Keefektifan

Kim, D., & Runco, M. A. (2022). Role of Cognitive Flexibility in Bilingualism and Creativity. *Journal of Creativity*, *32*(3), 100032. https://doi.org/10.1016/j.yjoc.2022.100032

Leasa, M., Papilaya, P. M., Batlolona, J. R., & Nuniary, S. (2023). Project-based Learning: Changing Students' Scientific Thinking to Be Creative from Waste Natural Materials. *Jurnal Penelitian Pendidikan IPA*, *9*(1), 350–359. https://doi.org/10.29303/jppipa.v9i1.2459

Lebuda, I., & Benedek, M. (2023). A systematic framework of creative metacognition. *Physics of Life Reviews*, *46*, 161–181. https://doi.org/10.1016/j.plrev.2023.07.002

Liang, W., & Fung, D. (2021). Fostering critical thinking in English-as-a-second-language classrooms: Challenges and opportunities. *Thinking Skills and Creativity*, *39*, 100769. https://doi.org/10.1016/j.tsc.2020.100769

Luthvitasari, N., Made D. P., N., & Linuwih, S. (2012). Implementasi Pembelajaran Fisika Berbasis Proyek Terhadap Keterampilan Berpikir Kritis, Berpikir Kreatif Dan Kemahiran Generik Sains. *Journal of Innovative Science Education*, *1*(2), 93–97. Retrieved from https://journal.unnes.ac.id/sju/index.php/jise/article/view/630

Maor, R., Paz-Baruch, N., Grinshpan, N., Milman, A., Mevarech, Z., Levi, R., Shlomo, S., & Zion, M. (2023). Relationships between metacognition,

creativity, and critical thinking in self-reported teaching performances in project-based learning settings. *Thinking Skills and Creativity*, *50*, 101425. https://doi.org/10.1016/j.tsc.2023.101425

Munandar, U. (2014). *Pengembangan Kreativitas Anak Berbakat*. Rineka Cipta.

Nurjamilah, I. P., & Muttaqin, M. (2020). Kemampuan Berpikir Kreatif Siswa Pada Sistem Pernapasan Melalui Penerapan Team Game Turnamen (TGT) Berbantu Monopoli. *Jurnal BIOEDUIN: Program Studi Pendidikan Biologi*, *10*(2), 41–49. Retrieved from https://journal.uinsgd.ac.id/index.php/bioeduin/article/view/12088

Pan, A.-J., Lai, C.-F., & Kuo, H.-C. (2023). Investigating the impact of a possibility-thinking integrated project-based learning history course on high school students' creativity, learning motivation, and history knowledge. *Thinking Skills and Creativity*, *47*, 101214. https://doi.org/10.1016/j.tsc.2022.101214

Poutiainen, A. (2012). Stay Creative! - Maintaining Individual Potential through Music Education. *Procedia - Social and Behavioral Sciences*, *45*, 507–516. https://doi.org/10.1016/j.sbspro.2012.06.588

Prihatin, R. (2021). The Analysis of Students' Creative Thinking Skills through the Implementation of the Project Based Learning Model in Social Studies Learning. *International Journal Pedagogy of Social Studies*, *6*(2), 9–16. https://doi.org/10.17509/ijposs.v6i2.28622

Putra, A. B. N. R., Syafrudie, H. A., Yunos, J. M., Nidhom, A. M., Smaragdina, A. A., & Sembiring, A. I. (2019). Analysis of the Necessity for Heutagogical Approach Through 4Cs Skills as Innovation for Vocational Lectures in the Education 4.0. *Proceedings of the 1st Vocational Education International Conference (VEIC 2019)*. https://doi.org/10.2991/assehr.k.191217.059

Rafik, M., Vini Putri Febrianti, Afifah Nurhasanah, & Siti Nurdianti Muhajir. (2022). Pengaruh model pembelajaran Project Based Learning (PjBL) terhadap kreativitas siswa guna mendukung pembelajaran abad 21. *Jurnal Pembelajaran Inovatif*, *5*(1), 80–85. https://doi.org/10.21009/jpi.051.10

Salmon, A. K., & Barrera, M. X. (2021). Intentional questioning to promote thinking and learning. *Thinking Skills and Creativity*, *40*(March), 100822. https://doi.org/10.1016/j.tsc.2021.100822

Sari, S. P., Manzilatusifa, U., & Handoko, S. (2019). Penerapan Model Project Based Learning (PjBL) untuk Meningkatkan Kemampuan Berfikir Kreatif Peserta Didik. *Jurnal Pendidikan Dan Pembelajaran Ekonomi Akuntansi*, *5*(2), 119–131. Retrieved from http://jurnal.fkip.unla.ac.id/index.php/jp2ea/article/view/329

Siagian, R. C. (2022). *Inovasi pembelajaran di abad 21* (1st ed.). Pradina Pustaka.

Suherman, S., & Vidákovich, T. (2022). Assessment of mathematical creative thinking: A systematic review. *Thinking Skills and Creativity*, *44*(February), 101019. https://doi.org/10.1016/j.tsc.2022.101019

Surya, R., & Irwandi. (2021). Peningkatan keterampilan berpikir kreatif siswa melalui model Project Based Learning (PjBL). *BIOEDUSAINS: Jurnal Pendidikan Biologi Dan Sains*, *4*(March), 1–19. https://doi.org/https://doi.org/10.31539/bioedusains.v4i2.2503

Surya, R., & Wahyudin, D. (2012). Project based learning untuk meningkatkan berpikir kreatif siswa SD pada materi makanan dan kesehatan. *Jurnal Penelitian Pendidikan*, 235–243. https://doi.org/https://doi.org/10.17509/jpp.v16i3.4817

Thornhill-Miller, B., Camarda, A., Mercier, M., Burkhardt, J.-M., Morisseau, T., Bourgeois-Bougrine, S., Vinchon, F., El Hayek, S., Augereau-Landais, M., Mourey, F., Feybesse, C., Sundquist, D., & Lubart, T. (2023). Creativity, Critical Thinking, Communication, and Collaboration: Assessment, Certification, and Promotion of 21st Century Skills for the Future of Work and Education. *Journal of Intelligence*, *11*(3), 54. https://doi.org/10.3390/jintelligence11030054

Tohir, M. (2019). Hasil PISA Indonesia Tahun 2018 Turun Dibanding Tahun 2015 (Indonesia's PISA Results in 2018 are Lower than 2015). In *Open Science Framework* (Vol. 2, Issue January). Retrieved from https://osf.io/pcjvx/download

Virtanen, A., & Tynjälä, P. (2019). Factors explaining the learning of generic skills: a study of university students' experiences. *Teaching in Higher Education*, *24*(7), 880–894. https://doi.org/10.1080/13562517.2018.1515195

Wahida, F., Rahman, N., & Gonggo, T. (2015). Pengaruh Model Pembelajaran Berbasis Proyek terhadap Keterampilan Berpikir Kreatif dan Hasil Belajar Siswa Kelas X Sma Negeri 1 Parigi. *Sains Dan Teknologi Tadulako*, *4*(3), 36–43. Retrieved from http://jurnal.untad.ac.id/jurnal/index.php/JSTT/article/view/6949

Wahyu, R., Islam, U., & Rahmat, R. (2018). Implementasi Model Project Based Learning (PJBL) Ditinjau dari Penerapan Kurikulum 2013. *Teknoscienza*, *1*(1), 50–62. Retrieved from https://ejournal.kahuripan.ac.id/index.php/TECNOSCIENZA/article/view/18

Zielińska, A., Lebuda, I., Ivcevic, Z., & Karwowski, M.

(2022). How adolescents develop and implement their ideas? On self-regulation of creative action. *Thinking Skills and Creativity*, *43*, 100998. https://doi.org/10.1016/j.tsc.2022.100998

Zulyusri, Z., Elfira, I., Lufri, L., & Santosa, T. A. (2023). Literature Study: Utilization of the PjBL Model in Science Education to Improve Creativity and Critical Thinking Skills. *Jurnal Penelitian Pendidikan IPA*, *9*(1), 133–143. https://doi.org/10.29303/jppipa.v9i1.2555