INKUIRI: Jurnal Pendidikan IPA
Vol. 11, No. 2, 2022 (hal 118-127)
https://jurnal.uns.ac.id/inkuiri

P-ISSN: 2252-7893
E-ISSN: 2615-7489
DOI: 10.20961/inkuiri.vx.ix.xxxx

THE LEARNING OF RESPIRATORY SYSTEM: IMPROVING STUDENTS' CREATIVE THINKING SKILLS THROUGH PROJECT-BASED LEARNING

Purwanti, Widha Sunarno, Sukarmin

Universitas Sebelas Maret

purwantispd@student.uns.ac.id, widhasunarno@staff.uns.ac.id, sukarmin67@staff.uns.ac.id

Diajukan: 25 April 2021; Diterima: 29 Mei 2022; Diterbitkan: 29 Oktober 2022

Abstrak: Keterampilan berpikir kreatif merupakan keterampilan krusial yang dibutuhkan oleh generasi saat ini dalam menghadapi tantangan abad ke-21. Penelitian yang berfokus pada keterampilan berpikir tingkat tinggi masih terbatas. Penelitian ini bertujuan untuk menganalisis pengaruh RPP pembelajaran berbasis proyek sistem pernapasan terhadap keterampilan berpikir kreatif siswa. Desain penelitian pretest and posttest dengan kelompok kontrol non-equivalent. Perlakuan yang diberikan pada kelas eksperimen adalah penerapan RPP berbasis proyek sistem pernapasan, sedangkan kelas kontrol menggunakan metode yang biasa digunakan oleh guru. Hasil penelitian ini menunjukkan bahwa kemampuan berpikir kreatif siswa kelas eksperimen lebih tinggi secara signifikan dibandingkan kelas kontrol. Kesimpulannya, RPP pembelajaran berbasis proyek sistem pernapasan efektif dalam meningkatkan kemampuan berpikir kreatif siswa.

Kata kunci: Pembelajaran berbasis proyek, kemampuan berpikir kreatif, sistem pernapasan

Abstract: *Creative thinking skills are the crucial skills required by nowadays generation in dealing with the 21st Century challenges. The researches focused on higher order thinking skills are still limited. This study aimed to analyze the effect of respiratory system project-based learning lesson plan on students'creative thinking skills. The research design was pretest and post-test with non-equivalent control group. The treatment given in experimental class was the implementation of respiratory system project-based learning lesson plan, while the control class was taught using common method used by the teachers. The results of this study indicated that the students' creative thinking skills in experimental class was significantly higher than the control class. In conclusion, respiratory system project-based learning lesson plan is effective in improving students' creative thinking skills.*

Keywords: *Project-based learning, creative thinking skills, respiratory system*

Introduction

Creative thinking is a logical activity to develop the available thinking results (Siti Zubaidah et al., 2017). According to Greenstein Greenstein (2012), creative thinking is a mental activity to increase originality and insight in the development of something. Another concept of creative thinking is logical and divergent thinking to generate new ideas (Türkmen & Sertkahya, 2019). According to (Tiantong & Siksen, 2013), creative thinking is an original cognitive ability and problem-solving process for individuals to use intelligence in a unique and directed manner. Genuine cognitive abilities emphasize cognitive outcomes that unique and different from other people's thinking (Retnawati et al., 2018; Tiantong & Siksen, 2013). The capability of students to provide various kinds of solutions to problems indicates that students can think creatively (Umami et al., 2019). Bono(2014); Ulger & Morsunbul(2016) describe the results of creative thinking consisting of formulating ideas; generate new ideas, and determine their effectiveness.

Creative thinking skills are the goal of Indonesian education development and writing in the Regulation of the Minister of Education of the Republic of Indonesia No. 6 of 2013 concerning the Curriculum of 2013 (Permendikbud, 2016). The policy shows that creative thinking skills are crucial. This statement had supported by Bono (2014), creative thinking skills are notable for people to improve lives, design innovation, and improve systems. Türkmen & Sertkahya (2019) strengthens this opinion by assessing that creative individuals provide new ideas for solutions to problems that occur in daily life or the results of practical studies. This assessment could indirectly have supported by Ritter &

P-ISSN: 2252-7893
E-ISSN: 2615-7489
DOI: 10.20961/inkuiri.vx.ix.xxxx

Mostert (2017), creative thinking skills provide people with the skills to face the opportunities and challenges of a complex world development flexibly.

Students need practice to get used to creative thinking skills. The train of creative thinking skills for students could apply through creative learning to find various solutions to problems that have to occur (Sung et al., 2016). Mrayyan (2016) describes that creative learning makes students the center of learning to develop skills to find various solutions to problems that appear. The teacher's task is to direct students to think creatively through learning opportunities according to the interests and needs of students (Nurlaela, 2015; Rahardjanto et al., 2019; Yusnaeni et al., 2017). Creative learning could apply with varied learning methods, so students actively seek solutions and develop an interest in learning (Lamb et al., 2015; Saefullah et al., 2021; Sun et al., 2020).

The basic concepts of science subjects learning focus on the process, product, and scientific attitude (Trianto, 2011). In the procedure of learning science to students pay attention to memorizing theories, analysis, and practice (S. U. Putri et al., 2019; Saefullah et al., 2021; Sumarni & Kadarwati, 2020; Umami et al., 2019). The operation of learning science subjects can observe in the learning of the respiratory system subjects. The respiratory system learning subjects have the characteristics of abstract, contextual, and sub-subjects that could have observed directly. The feature of the subjects requires separate descriptions and practices so that students understand (Anazifa & Djukri, 2017).

Currently, the orientation of science subjects learning by teachers still focuses on the ability of students to master only science products in the form of concepts, facts, and theory (Arti & Ikhsan(2020); Ratnasari et al. (2020); Zulaichah et al. (2020). This learning method may observe from the respiratory system subjects. Learning about respiratory system subjects for students focuses on image visualization as a learning medium. However, the subjects visualization method is less effective in developing aspects of the process and attitudes of students in science learning (Anazifa & Djukri, 2017). This condition obstructs the process of creative thinking skills for students (Nurlaela, 2015).

Therefore, the learning method to increase the activity of students in asking questions, opinions, or observing the object of the learning subjects needs to be developed (Adam & Gullota, 1983). Other activities include skills generalizing solutions to problems and adapting to different ideas that need developing in learning methods (Feeman, 2016). These activities are suitable for a scientific approach to learning (Andersen & Hepburn, 2015; Fudge, 2014). Scientific learning connects students' perspectives on the learning process, so it is systematic according to the scientific method (Andersen & Hepburn, 2015; Fudge, 2014). These learning activities expect students to design and find a solution to the problem has taught (Andersen & Hepburn, 2015;Stokvik et al., 2016). Creative thinking skills are a person's attitude to create an idea or ideas that are novelty and beneficial Siew & Ambo(2020)&Titu(2015). Scientific approach learning provides opportunities for divergent thinking students to practice creative thinking skills about novelty and solutions in life (Andersen & Hepburn, 2015; Fudge, 2014).

Project-based learning is a type of scientific approach learning method (Bender, 2012). Project-based learning involves a project in learning for students (Thomas, 2000). Projects implement by students can be done in groups or individually (Isabekov & Sadyrova, 2018). Students work on this project with a time limit set by the teacher (Isabekov & Sadyrova, 2018). The result of project-based learning is that students can present projects done with groups or individuals (Irianti, 2017). Project-based learning involves creativity, innovation, unique think, and a focus on solving problems in the lives of students (Anazifa & Djukri, 2017; Irianti, 2017; Wijayati et al., 2019).

Project-based learning stages improve students' creative thinking skills (Irianti, 2017; Wijayati et al., 2019). The opening syntax of the Project-based learning model is through essential questions for students to develop aspects of fluency and flexibility in phenomena, objects, or open problems that have presented in learning so that students raise various questions and ideas (J. Stivers & Brandon, 2010). The project plan stage helps students develop aspects of genuine and elaboration because students provide different answers from others, and projects design depending on

P-ISSN: 2252-7893
E-ISSN: 2615-7489
DOI: 10.20961/inkuiri.vx.ix.xxxx

the individual or group thinking of students. Students have targets and skills for development project settlement steps (J. Stivers & Brandon, 2010). The stage of scheduling and monitoring projects helps students develop the fluency aspect because students produce native ideas to organize and complete projects on time (Hsieh et al., 2013; J. Stivers & Brandon, 2010).

In the result assessment stage, students convey various kinds of thinking for problem-solving. The purpose of the outcome assessment stage is to develop fluency, originality, and elaboration for students (J. Stivers & Brandon, 2010; Tiantong & Siksen, 2013; Wijayati et al., 2019; S. Zubaidah et al., 2017). On the learning evaluation stage, students receive an explanation of the initial problem by the teacher, evaluate the projects carried out, and generalizing ideas for appropriate solutions. The purpose of the learning evaluation stage is to develop aspects of fluency and elaboration for students (Anazifa & Djukri, 2017; Irianti, 2017; Wijayati et al., 2019).

According to Ergül & Kargın (2014), project-based learning affects the practice of creative thinking skills. Knowledge development learners, creativity, and problem-solving through project simulations in class. Project-based learning increases the interest for study, providing opportunities for self-actualization to students effectively, and trains students' creative thinking skills (Gencer & Gonen, 2015).

Method

This study aims to test the effectiveness of project-based learning on respiratory system materials. The reference for this research is the Pretest-Posttest Nonequivalent Control Group Design (O_2 - O_1 X O_4 - O_3) (McKenney & Reeves, 2014). O_1 and O_3 are pretest scores, and X represents science learning on the topic of the respiratory system through project-based learning, while O_2 and O_4 are posttest scores. The population in this study was all of the students in 8th grades of 3 Junior High School Satu Atap Sumberlawang, Sragen, Indonesia, on the second semester of the academic year 2020/2021. The samples have selected by purposive random sampling. The random sampling technique chose due to the population was homogeneous, and each member had the same opportunity for picked as objects of this study. Simple random sampling had done by the lottery methods. The selected class has used as a control class and the other class as an experimental class. The control class consisted of 32 students, while the experiment class consisted of 32 students. The control class was treated by teaching and learning process using the conventional method (lecture method) and textbooks as usual. The experiment had treatment by implementing project-based learning to improve creative thinking skills that had previously developed. Each class obtains 6-time learning meetings.

The instrument consists of 7 essay questions adapted from each aspect of Guildford's theory about creative thinking skills, namely: (1) fluency, (2) flexibility, (3) originality, and (4) elaboration (Guilford, 1967). The percentage categories of students' creative thinking skills showed in Table 1. The instruments used in this study tested for validity and reliability by 31 students.

Table 1. Precentage Category of Students' Creative Thinking Skills

Percentage Range (%)	Category
81 – 100	Very creative
61 – 80	Creative
41 – 60	Enough
21 – 40	Low
0 - 20	Very low

ANCOVA has used for data analysis pretest score as the covariate. The significance level of analysis 0.05 and preceded a prerequisite test, namely the Shapiro-Wilk normality test and Levene's homogeneity test. The statistical analysis program used SPSS 22 for windows. N-gain was used to determine the effectiveness of the developed product to improve creative thinking skills after the project-based learning process. The n-gain category could see in Table 2.

Table 2. Score Category of N-gain

N-Gain <g>	Category
$<g> < 0.25$	Low
$0.25 \leq <g> < 0.45$	Medium-low
$0.45 \leq <g> < 0.65$	Medium-high
$<g> \geq 0.65$	High
$<g> < 0.25$	Low

P-ISSN: 2252-7893
E-ISSN: 2615-7489
DOI: 10.20961/inkuiri.vx.ix.xxxx

Results and Discussion

Result

Generally, the results of the analysis of students' creative thinking skills test scores could as seen in Figure 1.

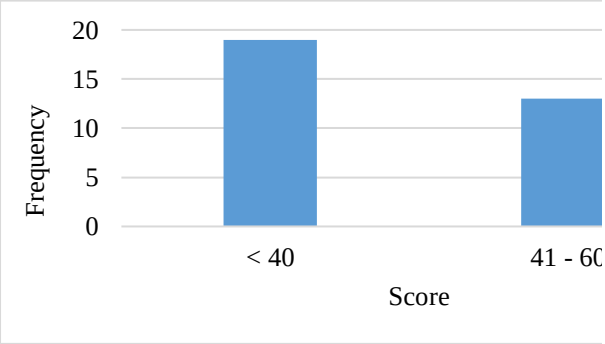

Figure 1. The General of Students' Creative Thinking Skill

Table 3. General Analysis of Students' Responses in Each Indicator of Creative Thinking Skills

Creative thinking skills indicators	Mean Score	Category
Fluency	33.02	Low
Flexibility	50.00	Enough
Originality	42.96	Enough
Elaboration	50.26	Enough

Table 4. Validation Results of Learning Tools Prototype

Validator	Percentage (%)	ry
Language	95.85	lid
Media	96.66	lid
Material	96.87	lid
Learning	92.86	alid
Educational practitioners	98.86	lid
Mean of all aspects	96.22	lid

Table 5. Results Analysis of Teachers Questionnaires

	Percentage (%)	Category
	91.66	Very valid
	91.66	Very valid
e	91.66	Very valid
	100.00	Very valid
f all aspects	93.75	Very valid

Table 6. Recapitulation of The Results of The Normality and Homogeneity Test

Class	Test	Type of test	Result
Exp.	Norm.	Shapiro-Wilk test	Sig. pretest 0.169; Sig. posttest 0. 148
Ctrl.	Norm.	Shapiro-Wilk test	Sig. pretest 0.336; Sig. posttest 0.070
All Class	Homogeneity	Levene's test	Sig. pretest 0.267; Sig. posttest 0.033

Table 7. ANCOVA Test Result

Source	Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	4295.434[a]	2	2147.717	86.327	.000
Intercept	4444.609	1	4444.609	178.650	.000
Pretest	8.458	1	8.458	.340	.562
Metode	3360.873	1	3360.873	135.090	.000
Error	1517.610	61	24.879		
Total	410713.005	64			
Corrected Total	5813.044	63			

R Squared = ,739 (Adjusted R Squared = ,730)

Table 8. N-gain Students' Critical Thinking Skills Score of Pretest and Posttest

Groups	N-gain	Category
Exp.	0.76	High
Ctrl.	0.47	Medium-high

Table 9. N-gain Score on Each Indicator to Students' Critical Thinking Skills

Indicator	N-gain			
	Experimental	Category	Control	Category
Fluency	0.62	Medium-high	0.36	Medium-low
Flexibility	0.80	High	0.39	Medium-low
Originality	0.72	High	0.46	Medium-high
Elaboration	0.90	High	0.69	High

Discussion

Based on Figure 1, the students' creative thinking skills were low and average categories based on the test. 59% of students were poor creative thinking skills, and then 41% of students were in the averages category. The students' score of each indicator in creative thinking skills could see in Table 3. These results based on Table 3 indicated that the learning process carried out so far couldn't improve students' creative thinking skills. Thus, significant efforts are needed to be able to help raise creative thinking skills. Creative thinking skills are essential for individuals to improving life, innovate designs, create change, and increase systems (Bono, 2014). According to Ritter & Mostert (2017), creative thinking skills allow people to remain flexible and provide skills to face the opportunities and challenges of a complex and rapidly changing world development. At this stage, an analysis of the need to develop learning devices on respiratory system material had carried out to raise creative thinking skills. The respiratory system has chosen because it has the characteristics of abstract, contextual material, and sub materials that could not to observed directly (Anazifa &

P-ISSN: 2252-7893
E-ISSN: 2615-7489
DOI: 10.20961/inkuiri.vx.ix.xxxx

Djukri, 2017). So that students need a separate description to understand the material. Usually, respiratory system material has taught using pictures, but visualization using drawing is still less effective in improving students' creative thinking skills (Anazifa & Djukri, 2017).

Based on that analysis, the result use as a reference in designing learning devices. These references make the learning tools developed have characteristics. There are 5 main characteristics namely 1) improving creative thinking skills 2) based on concrete problems 3) student-centered 4) project-based learning, and 5) using authentic assessment. Besides being adjusted as the result of the preliminary study, the five characteristics also adapted of curriculum 2013 for the product (learning tools) to be easier to implement at the junior high school (SMP/MTs) level in Indonesia. The phase of the learning tools prototype was carried out by involving several experts as validators (language, media, material, and learning expert validator, and educational practitioners). The results of the validation of the learning kit indicated that the product based on project learning on respiratory system content was acceptable to use in learning from several revisions.

The effectiveness of science learning tools based on a project to increase creative thinking skills on the respiratory system was determined in disseminate stage. It was analyzed and stride under the effectiveness analysis indicators. The preliminary test use normality and homogeneity held on experimental to control class indicate that the spread of data is normalcy and homogeneous. Based on Table 6, it concluded that the normality test using the Shapiro-Wilk test showed that the pretest and posttest were normal distributing ($\alpha > 0.05$), the Levene's homogeneity test in all classes showed homogeneous pretest and posttest because of the significance level ($\alpha > 0.05$).

The next test is ANCOVA to determine the difference in post-test values in the experimental class to the control class. Based on Table 7, there is a significant difference between the post-test value of the experiment class and the control class ($\alpha < 0.05$). The result of research that was told by Nugroho et al., 2017); Rati et al., 2017; Safrina, 2019; Yamin et al., 2020a shows the project design competent to raising students' creative thinking skills.

Table 7 shows have a significant difference in the creative thinking skills in pattern or gap of students learning used science learning tools based on a project in the respiratory system. The comparison of different treatment in students taught using conventional learning resources (control groups). The effectiveness of increasing creative thinking skills in students shown in Table 8.

The effectiveness of student improvement of the creative thinking skills score of the experimental group was confirmed not to be lower than the control group. This influence appears because each stage in the project-based learning model supports the progression of students' creative thinking skills following: (1) starting with essential questions; (2) designing project plans; (3) making schedules; (4) monitoring students on the progress of the project; and (5) assess the results of reflection (Bender, 2012;Siew & Ambo, 2020). . These activities encourage students to work independently to build learning and ultimately produce substantive work (Anazifa & Djukri, 2017; Wijayati et al., 2019; Yamin et al., 2020b; Yustina et al., 2020; Zakiah & Fajriadi, 2020). The detailed perspective of each critical thinking indicator by Guilford (1967) due to the N-gain scores of the two groups has shown in Table 9.

The fluency indicator students' creative thinking skills in the experimental class were higher than in the control class. It occurs because students guide to express opinions or ideas when phenomena display in everyday life. This skill is answers problems given by educators in the learning process (Guilford, 1967). It supports the thought of education experts that students can express ideas smoothly (Vally et al., 2019). In addition to this, fluency is not only based on outcome assessment alone. The valuation of students' fluency indicators drawn on the problem-solving skills gives by the educator (Wojciehowski & Ernst, 2018). Fluent thinking skills can be improved and developed through the activity to guiding in conveying ideas (Putri et al., 2019). The project-based learning model significantly improves expressing ideas smoothly in solving a problem given by the

P-ISSN: 2252-7893
E-ISSN: 2615-7489
DOI: 10.20961/inkuiri.vx.ix.xxxx

educator (Umami et al., 2019; Yamin et al., 2020b).

On Flexibility, the experimental class is superior. It occurs because students guide to design activities or stages has conducted to complete independent thinking-oriented projects. (Guilford, 1967). Through such actions, students can design ideas in preparing the schedule. Students will hold questions and answers that can add information and practice assessing things from various points of view to trains their thinking skills.(Nurlaela, 2015; Türkmen & Sertkahya, 2019). Students will get used to developing ideas according to their creativity. This situation is in line with education experts that students could develop or add opinions so that detailed or ideas produced.(Bakir & Öztekin, 2014; Yazar Soyadı, 2015). Flexibility is the ability to propose a variety of problem-solving approaches. (Lamb et al., 2015). If this point has implemented, it could elaborate and generate for students to communicate their work in detail. (Ndiung et al., 2021). It is in line with what Anazifa & Djukri (2017) & Türkmen & Sertkahya (2019) stated that the flexibility aspect could increase in the project-based learning model through stages of planning a project.

On originality, experimental class students are guided and given the freedom of several alternatives in create projects.(Guilford, 1967). Through guidance and liberty, students can develop original thinking skills and develop their creativity. Original thinking skills require the development of fluency and flexibility aspects first. These two aspects will optimize in achieve students' original thinking skills (Rawlinson, 2017; Zhang & Kwan, 2018). In efforts to develop original thinking skills, educators should encourage students to give answers or other ideas as an alternative to developing thinking skills. (Ahmad et al., 2021).

In elaboration, students conclude learning based on the concepts studied (Guilford, 1967). In addition, students answer the initial problem with the concepts discussed. Students learn to modify or like to take a simple thought, modify and make it more interesting (An et al., 2016; Bakir & Öztekin, 2014; Rawlinson, 2017; Yusnaeni et al., 2017). Add details to particular thinking provided these details match the main idea (Nurlaela, 2015; Wojciehowski & Ernst, 2018; Yazar Soyadı, 2015). This condition, of course, requires deep thought because it needs to be analyzed carefully. Students answer the initial problem with the concepts studied. Problem-solving is also not an easy thing for students to do, so students are required to learn concepts more deeply. It makes students in the experimental class have higher elaboration skills improvement compared to the control class.

Based on this description, we know that the project-based learning model could see as a model for creating a learning environment that can encourage students to construct knowledge and skills personally. The opportunity to convey ideas, listen to other people's ideas, and reflect on their ideas on other people's ideas, is a form of knowledge empowerment experience (meaning-making process) (Kutlu, 2015; Zakiah & Fajriadi, 2020). In addition, students also experience a learning stage known as the "Interactive Research Cycle" which consists of the stages of questioning, planning, collecting data, synthesizing knowledge, and evaluating (Isabekov & Sadyrova, 2018; J. Stivers & Brandon, 2010).

The project-based respiratory system learning process also received a positive response from students. The domain of attitude relates to curiosity, honesty, thoroughness, responsibility, and openness. This assessment has taken from students during the learning process is completed in each cycle. Action improvements as independent thinking skills, guidance in conveying ideas, direction to choosing alternative opinions, and group freedom can impact attitude from curious students, honest, thoroughness, responsible, open during the learning process (Guerra & Noll, 2021; Kutlu, 2015; Rahardjanto et al., 2019). The increased behavior strengthens by Santrock (2011), told that student behavior had shown in-depth and broadly based on their learned, seen, and heard.

Conclusion

The treatment given to students was science learning process with the combination of developed respiratory system project-based learning tools on students' creative thinking skills. Students in the two groups were given the same test as pretest and post-test. The

P-ISSN: 2252-7893
E-ISSN: 2615-7489
DOI: 10.20961/inkuiri.vx.ix.xxxx

results of this study indicated: 1) there is a significant difference between the post-test scores of students' creative thinking skills in each group with significant value = .000; 2) the average n-gain creative thinking skills of the experimental group students was higher. Yet, respiratory system with project-based learning was effectively enhancing and improving students' thinking pattern as creative thinking learners.

Science learning with project-based learning is expected to be implemented in all subjects to make students have better thinking skills, and project-based learning should be more developed with various innovations. Hopefully, this current research can complement innovation in science learning, especially project-based learning.

References

Adam, R. G., & Gullota, T. (1983). *Adolescent Life Experiences*. California: Brooks/Cole Publishing Company.

Ahmad, D. N., Astriani, M. M., Alfahnum, M., & Setyowati, L. (2021). Increasing creative thinking of students by learning organization with steam education. *Jurnal Pendidikan IPA Indonesia*, *10*(1), 103–110. https://doi.org/10.15294/jpii.v10i1.27146

An, D., Song, Y., & Carr, M. (2016). A comparison of two models of creativity: Divergent thinking and creative expert performance. *Personality and Individual Differences*, *90*(February), 78–84. https://doi.org/10.1016/j.paid.2015.10.040

Anazifa, R. D., & Djukri. (2017). Project- based learning and problem- based learning: Are they effective to improve student's thinking skills? *Jurnal Pendidikan IPA Indonesia*, *6*(2), 346–355.https://doi.org/10.15294/jpii.v6i2.11100

Andersen, H., & Hepburn, B. (2015). *Scientific Method*. The Metaphysics Research Lab. Stanford Encyclopedia of Philosophy. https://plato.stanford.edu/entries/scientific-method/

Arti, Y., & Ikhsan, J. (2020). The profile of Junior High School students' critical thinking skills and concept mastery level in local wisdom based on outdoor learning. *Journal of Physics: Conference Series*, *1440*(1).https://doi.org/10.1088/17426596/1440/1/012105

Bakir, S., & Öztekin, E. (2014). Creative thinking levels of preservice science teachers in terms of different variables. *Journal of Baltic Science Education*, *13*(2), 231–242.

Bender, W. (2012). *Project-Based Learning Differentiating Instruction for the 21st Century*. United States of America: Corwin a Sage Company.

Bono, E. de. (2014). Creative and Lateral Thinking. *Encyclopedia of Educational Theory and Philosophy*, *June*.https://doi.org/10.4135/9781483346229.n86

Ergül, N. R., & Kargın, E. K. (2014). The Effect of Project based Learning on Students' Science Success. *Procedia - Social and Behavioral Sciences*, *136*, 537–541. https://doi.org/10.1016/j.sbspro.2014.05.371

Feeman, E. (2016). *Torrance Journal for Applied Creativity* (Vol. 1). Athens, GA: Torrance Center for Creativity and Talent Development.

Fudge, D. S. (2014). Scientific Method: Fifty years of J. R. Platt's strong inference. *The Journal of Experimental Biology*, *217*(8), 1202–1204. https://doi.org/10.1242/jeb.104976

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*(312),456–460.https://doi.org/10.1016/j.sbspro.2015.04.120

Greenstein, L. (2012). *Accessing 21 century skills: To guide to evaluating mastery and authentic learning.* USA: Corwin Press, INC.

Guerra, G. F., & Noll, M. (2021). Scientific Methodology in Integrated High Schools: A Case Study. *International Journal of Instruction*, *14*(2), 571–590. https://doi.org/10.29333/iji.2021.14232a

Guilford, J. P. (1967). *The Nature of Human Intelligence*. New York: McGraw-Hill.

Hsieh, H. Y., Lou, S. J., & Shih, R. C. (2013). Applying Blended Learning with Creative

P-ISSN: 2252-7893
E-ISSN: 2615-7489
DOI: 10.20961/inkuiri.vx.ix.xxxx

Project Based Learning: A Case Study of Wrapping Design Course for Vocational High School Students. *Journal of Science And Technology*, *3*(2), 18–27.

Irianti, R. (2017). Improving Creative Thinking Skills by Implementing Project Based Learning on Human Organ System Material. *Advances in Social Science, Education and Humanities Research*, *100*, 376–378. https://doi.org/10.2991/seadric-17.2017.81

Isabekov, A., & Sadyrova, G. (2018). *Project-Based Learning to Develop Creative Abilities in Students*. 43–49.

J. Stivers, & Brandon, G. (2010). Project-Based Learning Why Use It? *Educational Psychology*, *ESPY 505*, 1–8.

Kutlu, N. (2015). The Effect Of Purdue Model Based Science Teaching On Creative Thinking. *International Journal OfEducation and Research*, *3*(3), 589–600.

Lamb, R., Annetta, L., & Vallett, D. (2015). The interface of creativity, fluency, lateral thinking, and technology while designing Serious Educational Games in a science classroom. *Electronic Journal of Research in Educational Psychology*, *13*(2), 219–242. https://doi.org/10.14204/ejrep.36.14110

McKenney, S., & Reeves, T. C. (2014). Educational design research. *Handbook of Research on Educational Communications and Technology: 4th Ed*, 131–140. https://doi.org/10.1007/978-1-4614-31855_11

Mrayyan, S. (2016). Investigating mathematics teacher's role to improve students creative thinking. *American Journal of Educational Research*, *4*(1), 82–90.

Ndiung, S., Sariyasa, Jehadus, E., & Apsari, R. A. (2021). The effect of treffinger creative learning model with the use rme principles on creative thinking skill and mathematics learning outcome. *International Journal of Instruction*, *14*(2), 873–888. https://doi.org/10.29333/iji.2021.14249a

Nugroho, G. A., Prayitno, B. A., & Ariyanto, J. (2017). Peningkatan Kemampuan Berpikir Kreatif Melalui Penerapan Project Based Learning Pada Materi Pencemaran dan Daur Ulang Limbah. *Jurnal Pembelajaran Biologi*, *6*(2), 9–12.

Nurlaela, L. (2015). Developing Creative Thinking Skills in Learning at Higher-Educational Institution of Teacher. *Proceedings of the 3rd UPI International Conference on Technical and Vocational Education and Training*, *14*(January 2015). https://doi.org/10.2991/ictvet-14.2015.26

Permendikbud. (2016). Peraturan Menteri Pendidikan dan Kebudayaan No. 22 Tahun 2016 - Standar Proses Pendidikan Dasar dan Menengah. *Jakarta: Menteri Pendidikan Dan Kebudayaan Republik Indonesia*, 1–15.

Putri, N., Rusdiana, D., & Suwarma, I. R. (2019). The Comparison of Student Creative Thinking Skill using CBL Implemented in STEM Education and Combined with PSL Worksheet in Indonesian School. *Journal of Science Learning*, *3*(1), 7–11.https://doi.org/10.17509/jsl.v3i1.17557

Putri, S. U., Sumiati, T., & Larasati, I. (2019). Improving creative thinking skill through project-based-learning in science for primary school. *Journal of Physics: Conference Series*, *1157*(2). https://doi.org/10.1088/1742-6596/1157/2/022052

Rahardjanto, A., Husamah, & Fauzi, A. (2019). Hybrid-PjBL: Learning outcomes, creative thinking skills, and learning motivation of preservice teacher. *International Journal of Instruction*, *12*(2), 179–192. https://doi.org/10.29333/iji.2019.12212a

Rati, N. W., Kusmaryatni, N., & Rediani, N. (2017). Model Pembelajaran Berbasis Proyek, Kreativitas Dan Hasil Belajar Mahasiswa. *JPI : Jurnal Pendidikan Indonesia*, *6*(1), 60–71.

Ratnasari, N., Sarwanto, & Prayitno, B. A. (2020). The role of students' critical thinking skills in junior high schools on chapter organism and its environment. *J. Phys.: Conf. Ser.*, *1511*(012064). https://doi.org/10.1088/1742-6596/1511/1/012064

Rawlinson, J. G. (2017). *Creative Thinking and Brainstorming*. Taylor & Francis.

Retnawati, H., Djidu, H., Kartianom, Apino, E., & Anazifa, R. D. (2018). Teachers' knowledge about higher-order thinking skills and its learning strategy. *Problems of Education in*

P-ISSN: 2252-7893
E-ISSN: 2615-7489
DOI: 10.20961/inkuiri.vx.ix.xxxx

the 21st Century, *76*(2), 215–230. https://doi.org/10.33225/pec/18.76.215

Ritter, S. M., & Mostert, N. (2017). Enhancement of Creative Thinking Skills Using a Cognitive-Based Creativity Training. *Journal of Cognitive Enhancement*, *1*(3), 243–253. https://doi.org/10.1007/s41465-016-0002-3

Saefullah, A., Suherman, A., Utami, R. T., Antarnusa, G., Rostikawati, D. A., & Zidny, R. (2021). Implementation of PjBL-STEM to Improve Students' Creative Thinking Skills On Static Fluid Topic. *JIPF (Jurnal Ilmu Pendidikan Fisika)*, *6*(2), 149. https://doi.org/10.26737/jipf.v6i2.1805

Safrina, D. (2019). *Keterampilan dan Kemampuan Berpikir Kreatif Siswa dengan Menggunakan Model Project Based Learning (PjBL) pada Materi Sistem Ekskresi di MTSn 3 Bireuen*. Fakultas Tarbiyah dan Keguruan Universitas Islam Negeri Ar-Raniry Darussalam.

Santrock, J. W. (2011). *Psikologi Pendidikan, Edisi Kedua*. Jakarta: Kencana.

Siew, N. M., & Ambo, N. (2020). the Scientific Creativity of Fifth Graders in a Stem Project-Based Cooperative Learning Approach. *Problems of Education in the 21st Century*, *78*(4), 627–643. https://doi.org/10.33225/pec/20.78.627

Stokvik, H., Adriaenssen, D., & Johannessen, J.-A. (2016). Tacit knowledge, organizational learning and innovation in organizations. *Problems and Perspectives in Management*, *14*(3), 246–255.https://doi.org/10.21511/ppm.14(3-1).2016.11

Sumarni, W., & Kadarwati, S. (2020). Ethno-stem project-based learning: Its impact to critical and creative thinking skills. *Jurnal Pendidikan IPA Indonesia*, *9*(1), 11–21. https://doi.org/10.15294/jpii.v9i1.21754

Sun, M., Wang, M., & Wegerif, R. (2020). Effects of divergent thinking training on students' scientific creativity: The impact of individual creative potential and domain knowledge. *Thinking Skills and Creativity*, *37*.https://doi.org/10.1016/j.tsc.2020.100682

Sung, Y. T., Chang, K. E., & Liu, T. C. (2016). The effects of integrating mobile devices with teaching and learning on students' learning performance: A meta-analysis and research synthesis. *Computers and Education*, *94*, 252–275. https://doi.org/10.1016/j.compedu.2015.11.008

Thomas, J. W. (2000). A Review of Research on Project Based Learning. *Bob Pearlman Home Project-Based Learning 21st Century Learning*. http://www.bie.org/resea
rch/study/review_of_project_based_learning_2000

Tiantong, M., & Siksen, S. (2013). The Online Project-based Learning Model Based on Student's Multiple Intelligence. *International Journal of Humanities and Social Science*, *3*(7), 53–72. https://doi.org/10.2217/EBO.13.11

Titu, M. A. (2015). Penerapan Model PjBL untuk Meningkatkan Kreativitas Siswa pada Materi Konsep Masalah Ekonomi. *Prosiding Seminar Nasional*, 176–186. https://eprints.uny.ac.id/21708/1/18 Maria Anita Titu.pdf

Trianto. (2011). *Model Pembelajaran Terpadu*. Jakarta: PT Bumi Aksara.

Türkmen, H., & Sertkahya, M. (2019). Creative Thinking Skills Analyzes of Vocational High School. *Journal of Educational and Instructional Studies*, *5*(1), 74–84.

Ulger, K., & Morsunbul, U. (2016). The difference in Creative Thinking: The Comparison of Male and Female Students. *The Online Jurnal of Counseling and Education*, *5*(4), 1–12.

Umami, R. N., Susilo, H., & Mahanal, S. (2019). Improving Creative Thinking Skills of Students Through Learning Based on Simple Hydroponic Projects. *Jurnal Pendidikan Sains S3*, *7*(3), 111–115. http://journal.um.ac.id/index.php/jps/

Vally, Z., Salloum, L., AlQedra, D., El Shazly, S., Albloshi, M., Alsheraifi, S., & Alkaabi, A. (2019). Examining the effects of creativity training on creative production, creative self-efficacy, and neuro-executive functioning. *Thinking Skills and Creativity*, *31*(October 2018), 70–78. https://doi.org/10.1016/j.tsc.2018.11.003

Wijayati, N., Sumarni, W., & Supanti, S. (2019). Improving Student Creative Thinking Skills

P-ISSN: 2252-7893
E-ISSN: 2615-7489
DOI: 10.20961/inkuiri.vx.ix.xxxx

Through Project Based Learning. *KnE Social Sciences*, *January*. https://doi.org/10.18502/kss.v3i18.4732

Wojciehowski, M., & Ernst, J. (2018). Creative by Nature: Investigating the Impact of Nature Preschools on Young Children's Creative Thinking. *International Journal of Early Childhood Environmental Education*, *6*(1), 3–20.

Yamin, Y., Permanasari, A., Redjeki, S., & Sopandi, W. (2020a). Implementing project-based learning to enhance creative thinking skills on water pollution topic. *JPBI (Jurnal Pendidikan Biologi Indonesia)*, *6*(2), 225–232. https://doi.org/10.22219/jpbi.v6i2.12202

Yamin, Y., Permanasari, A., Redjeki, S., & Sopandi, W. (2020b). Project Based Learning To Enhance Creative Thinking Skills of the Non-Science Students. *Jhss (Journal of Humanities and Social Studies)*, *4*(2), 107–111.https://doi.org/10.33751/jhss.v4i2.2450

Yazar Soyadı, B. B. (2015). Creative and Critical Thinking Skills in Problem-based Learning Environments. *Journal of Gifted Education and Creativity*, *2*(2), 71–71. https://doi.org/10.18200/jgedc.2015214253

Yusnaeni, Y., Corebima, A. D., Susilo, H., & Zubaidah, S. (2017). Creative thinking of low academic student undergoing search solve create and share learning integrated with metacognitive strategy. *International Journal of Instruction*, *10*(2), 245–262. https://doi.org/10.12973/iji.2017.10216a

Yustina, Syafii, W., & Vebrianto, R. (2020). The effects of blended learning and project-based learning on pre-service biology teachers' creative thinking skills through online learning in the COVID-19 pandemic. *Jurnal Pendidikan IPA Indonesia*, *9*(3), 408–420. https://doi.org/10.15294/jpii.v9i3.24706

Zakiah, N. E., & Fajriadi, D. (2020). Hybrid-PjBL: Creative thinking skills and self-regulated learning of pre-service teachers. *Journal of Physics: Conference Series*, *1521*(3). https://doi.org/10.1088/1742-6596/1521/3/032072

Zhang, X., & Kwan, H. K. (2018). *Empowering Leadership and Team Creativity: The Roles of Team Learning Behavior*. Team Creative Efficacy, and Team Task Complexity. Routledge.

Zubaidah, S., Fuad, N. M., Mahanal, S., & Suarsini, E. (2017). Improving Creative Thinking Skills of Students through Differentiated Science Inquiry Integrated with Mind Map. *Journal of Turkish Science Education*, *14*(4), 77–91.

Zubaidah, Siti, Fuad, N. M., Mahanal, S., & Suarsini, E. (2017). Improving creative thinking skills of students through Differentiated Science Inquiry integrated with mind map. *Journal of Turkish Science Education*, *14*(4), 77–91. https://doi.org/10.12973/tused.10214a

Zulaichah, S., Sukarmin, S., & Masykuri, M. (2020). *Student Scientific Creativity Profile Based on Scientific Structure Creativity Model*. 198–205. https://doi.org/10.4108/eai.28-9-2019.2291015