JURNAL PENDIDIKAN FISIKA UNDIKSHA
p-ISSN : 2599-2554 (Print) e-ISSN : 2599-2562 (online)
Volume 14 No 2 Juli 2024
OPEN ACCESS

META-ANALYSIS: EFFECTIVENESS OF PROJECT-BASED LEARNING ON STUDENT CREATIVITY

P. Widiarini[1], A. A. I. A. R. Sudiatmika[2], K. Suma[3], I N. Suardana[4]
[1,2,3]Jurusan Fisika dan Pengajaran IPA, Universitas Pendidikan Ganesha, Singaraja
[4]Jurusan Kimia, Universitas Pendidikan Ganesha, Singaraja
e-mail: putu.widiarini@undiksha.ac.id

Abstract

This research is quantitative research with meta- analysis methods. The aim of this research is to describe the effectiveness of the project learning model on student creativity. The research sample consisted of 10 articles in the accredited national journal Sinta. All articles are the result of research on physical learning in the science group at the high school level. The data analysis technique used is calculating the effect size value. Based on the results of the meta- analysis, it was found that the average total effect size value was 1.55 with a standard deviation of 0.83, which was in the very high category. This shows that the problem-based learning model is effective in increasing student creativity. The results further show that the project-based learning model is also effective at various levels of high school and various physics subject matter.
Keywords : *creativity, effect size, meta-analysis, physics, project*

1. Introduction

21st century skills are skills that are very important for students to have, especially at the high school level, so that they can adapt to an increasingly advanced and developing world, especially in the fields of information media and technology (Umam & Jiddiyyah, 2021). 21st century skills which are often called 4C skills are critical thinking, creativity, communication, collaboration. One of the higher level thinking is creative thinking. As part of the 4C skills, it is mandatory for all students to practice thinking skills as early as possible so they can get used to higher level thinking. Teachers should be able to empower students to hone their thinking skills from an early age. One of the high-level thinking abilities is creative thinking which is able to give birth to creativity (Hermansyah et al., 2017). Creativity refers to the ability to find and use new ideas that may be unconventional or even strange, but are actually still rational within the scope of learning (Widiarini, et al., 2021). Thinking skills are needed to face the challenges of the times and increasingly stringent competencies. The fundamental characteristics of creative thinking are showing potential in solving problems, arguing based on facts and emotionally having the mental ability to complete tasks and responsibilities (Erdem & Adiguzel, 2019). Several previous researchers explained that students' creative thinking skills were not optimal so they needed to be improved or developed to make it easier for students to learn (Suratno, et al., 2019). There are students who are less able to make assumptions and make decisions because students' creative thinking skills are not trained during learning activities (Wojciehowski & Ernst, 2018).

Creative thinking skills are one of the most important competencies in this modern era, especially in the context of education and student self-development. In the midst of ever-changing global challenges, the ability to think creatively is the key to solving complex problems and adapting to new situations. Research shows that creative thinking skills are not only useful in academic contexts, but also in everyday life and the world of work, where innovation and creative solutions are needed (Fajri, 2024; Priyambodo et al., 2021). One important aspect of creative thinking skills is its ability to encourage students to explore new ideas and find alternative solutions. In education, teachers have a crucial role in developing these skills.

Creative thinking skills are also closely related to the use of technology in education. In the context of the 21st century, educational technology plays an important role in supporting the development of critical, creative and collaborative thinking skills. Research shows that technology can increase student engagement and facilitate a more dynamic learning process, thereby encouraging their creativity (Fajri, 2024; Hasanah et al., 2023). For example, the use of e-modules and online learning platforms can provide wider access for students to explore material and collaborate on creative projects (Hasanah et al., 2023). Furthermore, creative thinking skills are also influenced by psychological factors, such as self-confidence and motivation. Research finds that students who have high self-confidence tend to show better creative thinking skills. Therefore, it is important for educators to create a learning environment that supports and motivates students to actively participate in the learning process (Priyambodo et al., 2021; Anwar, 2023). Thus, the development of creative thinking skills depends not only on teaching methods, but also on the emotional and psychological support provided to students. Overall, creative thinking skills are a fundamental element in modern education that must be developed through the right approach and adequate support. By focusing on developing these skills, we can prepare future generations to face increasingly complex and dynamic challenges in a changing world.

As an alternative in directing students' thinking abilities so that students get used to empowering themselves during the learning process is to choose a learning model that suits the learning objectives. Various innovations in learning are needed to develop creative thinking skills as part of supporting global development which requires students to develop their thinking abilities to create many ideas (Cheung, 2018). One learning model that can be used as a facility to develop student creativity is the project-based learning model (Firdaus, et al., 2022; Widiarini, et al., 2022). The project-based learning model (PjBL) provides teachers with the opportunity to motivate students to develop appropriate strategies, design projects and carry out investigations in solving real problems faced (Nuraini & Waluyo, 2021). The project-based learning model is also one of the learning models recommended by the Ministry of Education and Culture to be implemented at all levels of education in the Merdeka curriculum era (Kemdikbud, 2020). The PjBL model will provide opportunities for students to carry out practical activities freely, search for various learning resources that are appropriate to the topic on the internet or other places, and collaborate with other students (Santyasa et al., 2020). There are six stages in the project- based learning model which synergize with the four dimensions of creativity so that students get more opportunities to develop their creative thinking abilities. The relationship between PjBL syntax and creativity dimensions is shown in Table 1.

Table 1. Creativity dimension according to PjBL syntax (Widiarini, et al., 2021)

No	PjBL Syntax	Developed creativity dimension
1	Start with the essential question	Fluency, flexibility
2	Design a plan for the project	Fluency, flexibility, originality
3	Create schedule	Fluency, flexibility
4	Monitor the project	Fluency, flexibility, originality
5	Asses the outcomes	Fluency, flexibility, originality, elaboration
6	Evaluate the experience	Fluency, flexibility, originality, elaboration

Through the application of the project-based learning model, it will provide opportunities for students to develop creative thinking skills with six effective learning steps as shown in Table 1. Each learning step will provide flexibility for students in developing aspects of creative thinking so that the development of creative thinking skills become more optimal. Creative thinking skills are very important in modern education, especially through the application of project-based learning (PjBL) models. This model not only encourages students to be actively involved in the learning process, but also increases their creative abilities in solving real problems. Research shows that PjBL is effective in increasing student creativity because it provides opportunities for collaboration, communication and critical thinking (Sungkono, 2023;

Noorhalida, 2024; Ekaputra, 2024). Therefore, in this article we will discuss the role of project-based learning models in developing students' creative thinking skills.

Based on the description above, this research using the meta-analysis method aims to describe the effectiveness of the project-based learning model on student creativity based on the effect size value. Bearing in mind the importance of developing students' creative thinking abilities as early as possible, especially at the high school level where students will be preparing to undertake further studies at the tertiary level.

2. Method

The method used in this research is the meta-analysis method, namely analyzing 10 articles published in the accredited national journal Sinta. Data was collected by reviewing and searching articles online. The article search stage uses the help of Google Scholar. The keywords used are "project-based learning", "creative thinking", and "creativity". The data collected in this paper is evaluated based on quality assessment criteria questions, namely: (1) is the journal accredited by Sinta?; (2) was the journal article published in the 2018-2023 period?; and (3) whether the journal article mentions information on indicators of creative thinking skill and project-based learning, as well as ways to generate and/or improve students' creative thinking skills. The inclusion and exclusion criteria established in this meta-analysis study are presented in Table 2.

Table 2. Inclusion and Exclusion Criteria

Criteria	Description
Inclusion	1. The data used are journal articles for the last 6 (six) years from 2018-2023. 2. Data is taken from the accredited journal Sinta. 3. Data describes indicators of creative thinking skills and ways to generate or improve creative thinking skills by using project-based learning.
Exclusion	1. The data does not contain complete indicators of creative thinking. 2. The data does not discuss how to generate or improve creative thinking skills by using project-based learning.

Researchers collected journal articles from Google Scholar, Research Gate, and SINTA. The keyword in this research is creative thinking skills. From the article search results, 45 articles were found with the scope of discussing creative thinking skills. The identified articles will go through several processes by the PRISMA chart (Zarate et al., 2022). Based on the objects and inclusion and exclusion criteria described above, in this study, 45 articles were identified. The articles that have been identified will go through several processes by the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses) chart which consists of 5 main steps, namely identification, screening, eligibility, and inclusion. Based on the five stages that have been carried out, 10 articles were obtained that were ready to be analyzed using meta analysis. Data for all articles are presented in Table 3.

Table 3. All articles data at senior high school level

Code	Title	Year of published	Authors	Level
A1	Peran Model Project Based Learning dalam Kemampuan Berpikir Kreatif Kelas XI IPA melalui Materi Fluida Dinamis	2018	Rani Nur Arifah Agus Fajrina, Supriyono Koes Handayanto, Arif Hidaya	XI
A2	Keterampilan Berpikir Kreatif Siswa SMA dalam Pembelajaran Project	2018	Wahyu Pramudita Sari, Arif Hidayat,	XI

	Based Learning (PjBL) pada Materi Fluida Statis		Sentot Kusairi	
A3	Efektivitas Model Pembelajaran Berbasis Proyek (Project Based Learning) Terhadap Keaktifan Dan Kemampuan Berpikir Kreatif Siswa Kelas X SMA N 2 Semarang	2018	Lilin Triani Putri, Harto Nuroso, Nur Khoiri	X
A4	Model *Project Based Learning* (PjBL) Berbasis Lesson Study Terhadap Kemampuan Berpikir Kreatif Siswa SMA	2018	Chusnul Fauziah, Duwi Nuvitalia, Ernawati Saptaningrum	XI
A5	Pengaruh Model Project Based Learning terhadap Keterampilan Berpikir Kreatif pada Materi Fluida Dinamis di SMA	2019	Zaskya Laksmitha Utami, Nurdin Bukit, Mariati P. Simanjuntak, Motlan	X
A6	Pengaruh Model Project Based Learning Berbasis STEM terhadap Kemampuan Berpikir Kreatif Siswa pada Materi Pokok Fluida Statis di Kelas XI SMA Negeri 4 Tebing Tinggi Tahun Pelajaran 2019/2020	2020		XI
A7	Efektivitas Model Project-Based Learning Terintegrasi STEM (PjBL-STEM) terhadap Keterampilan Berpikir Kreatif Siswa Kelas X	2020	Jimmi Andrew Mamahit, Duran Corebima Aloysius, Hadi Suwono	X
A8	Pengaruh Model Project Based Learning Terintegrasi 21st Century Skills terhadap Kemampuan Berpikir Kreatif Siswa SMA Fisika	2020	Nisa Nisriana Nurfa, Nana	XI
A9	Implemetation of PjBL-STEM to Improve Students' Creative Thinking Skills on Static Fluid Topic	2021	Asep Saefullah, Andri Suherman, Riska Tri Utami, Ganesha Antarnusa, Diana Ayu Rostikawati, Robby Zidny	XI
A10	Pengaruh Model Project Based Learning Terhadap Keterampilan Berpikir Kreatif Peserta Didik dalam Pembelajaran Fisika Materi Momentum Dan Impuls	2022	Firda Maulida Firdaus, Endang Surahman, Yanti Sofi Makiyah	X

The meta-analysis used is quantitative because it uses numerical calculations, namely calculating the effect size value. Effect size is a measure of the quantity of a research result to determine the correlation or difference between research variables (Putri & Zulyusri, 2022). The formula for calculating the effect size value is determined from data obtained from the article. Calculating the effect size value can use 1) group average value and standard deviation, 2) F test value, 3) t-test value, and 4) chi square value. The effect size categories are presented in Table 3.

Table 3. Effect Size Categories (Cohen, et al., 2018)

No	Effect Size (ES)	Category

1	0,00-0,19	Neglected
2	0,20-0,49	Small
3	0,50-0,79	Moderate
4	0,80-1,29	High
5	≥1,30	Very high

3. Result and Discussion

This research is quantitative research that uses meta-analysis methods. Based on the results of an analysis of 10 articles on Physics learning in high school from the publication years 2018 to 2022 in Indonesia. The results of calculating the effect size for each article are presented in Table 4.

Table 4. The categories of effect size articles

No	Code	Effect Size (ES)	Category
1	A1	1.38	Very high
2	A2	0.85	High
3	A3	2.41	Very high
4	A4	3.43	Very high
5	A5	1.83	Very high
6	A6	0.73	Moderate
7	A7	1.42	Very high
8	A8	1.35	Very high
9	A9	0.89	High
10	A10	1.22	Very high
	Average ES	1.55	Very high
	SD	0.83	

In this research, the grouping of article data is described based on grade level and main material as a need to analyze the author's needs for conducting further development research regarding learning models and student creativity. Data for grouping effect sizes based on class level and main material are presented in Table 4 and Table 5.

Table 5. The categories of effect size articles by level

No	Level	Code	Effect Size	Average	SD	Category
1	X	A3 A5 A7 A10	2.41 1.83 1.42 1.22	1.72	0.53	Very high
1	XI	A1 A2 A4 A6 A8 A9	1.38 0.85 3.43 0.73 1.35 0.89	1.44	1.01	Very high

Table 6. The categories of effect size articles by topic

No	Topic	Code	Effect Size	Average	SD	Category
1	Measurements	A3	2.41	2.41	-	Very high
2	Sound Wave	A4	3.43	3.43	-	Very high
3	Momentum and Impuls	A10	1.22	1.22	-	Very high

4	Static Fluid	A2 A6 A9	0,85 0,73 0,89	0.82	0.08	High
5	Dynamic Fluid	A1 A5 A8	1.38 1.83 1.35	1.52	0.27	Very high

Based on the results of data analysis in Table 4, it appears that the average effect size value for the effectiveness of the project-based learning model on student creativity is 1.55 with a standard deviation of 0.83 in the very high category. Based on the results of data analysis in Table 5, it appears that the effect size value for the effectiveness of the project-based learning model on student creativity at class X and XI levels is in the very high category, especially in class X SMA. This shows that the project-based learning model is worthy of being a learning model choice that can improve students' creative thinking abilities. Apart from that, based on the data in Table 6, it appears that the project-based learning model is effective in increasing student creativity in various subject matter. The highest effect is on sound wave material with an effect size value of 3.43. The lowest effect is on static fluid material, even though it is the lowest, the effect size for this topic is relatively high. This strengthens the theory that the project-based learning model is suitable for application at various grade levels in high school and various physics subject matter. This result has been confirmed by the results of research conducted by researchers in the articles studied with this meta-analysis.

One of the main advantages of PjBL is its ability to create a learning environment that supports exploration and innovation. In this context, students not only learn theory, but also apply their knowledge in real projects that are relevant to everyday life. For example, research shows that implementing PjBL in physics learning can improve students' creative thinking abilities, especially when teachers integrate creative thinking indicators in learning steps (Noorhalida, 2024; Sahtoni et al., 2017). In doing so, students learn to design and implement projects that require them to think creatively and critically. In addition, PjBL also contributes to the development of collaborative skills. In projects, students often work in groups, which allows them to share different ideas and perspectives. This not only enhances individual creativity, but also strengthens teamwork abilities. Research shows that students who are involved in PjBL tend to be more creative and able to collaborate well in completing group assignments (Ekaputra, 2024; Winarko, 2024; Harizon, 2023). Thus, PjBL does not only focus on the final results of the project, but also on the collaborative process that occurs during learning.

The importance of PjBL in increasing student creativity can also be seen from research results which show that this model can increase learning motivation. When students are involved in projects that they chose and designed themselves, they feel more responsible and motivated to achieve good results. Research shows that PjBL can increase students' learning motivation and creativity, which in turn contributes to better learning outcomes (Haswan, 2024; Usmeldi, 2019; Natalia, 2023). By giving students the freedom to explore and create, PjBL helps them develop the skills necessary to face the challenges of the 21st century. Overall, the application of the project-based learning model (PjBL) has proven to be effective in improving students' creative thinking skills. Through this approach, students not only learn to complete assignments, but also develop critical, collaborative, and creative thinking skills that are so needed in an ever-changing world. Therefore, it is important for educators to integrate PjBL in their curriculum to prepare students to face future challenges.

4. Conclusion and Recommendation

Based on the results of the meta-analysis, it was found that the average total effect size value was 1.55 with a standard deviation of 0.83, which was in the very high category. This shows that the problem-based learning model is effective in increasing student creativity. The results further show that the project-based learning model is also effective at various levels of high school and various physics subject matter. As part of the needs analysis for further research activities, these results can be used as a basis for testing project-based learning

models which can be combined with other variables so as to increase the effectiveness of this model on creative thinking abilities or other abilities.

5. Acknowledgement

Thank you to all the authors of the articles used in this meta-analysis study so that this paper can be completed.

References

Cheung, R. H. P. (2018). Play-based Creativity Fostering Practices: The Effects of Different Pedagogical Approaches on The Development of Children's Creative Thinking Behaviours in a Chinese Preschool Classroom. *Pedagogy, Culture and Society*, 26(4), 511-527. https://doi.org/10.1080/14681366.2018.1424725

Cohen, L., Manion, L., & Morrison, K. 2018. *Research Methods in Education (8th edition).* Routledge Taylor & Francis Group.

Ekaputra, F. (2024). Increasing student creativity and collaboration in biochemistry practicum through the application of project based learning model. *Eduline Journal of Education and Learning Innovation*, 4(1), 105-109. https://doi.org/10.35877/454ri.eduline2428

Erdem, A. R., & Adiguzel, D. C. (2019). The Opinions of Primary School Teachers on their Creative Thinking Skills. *Eurasian Journal of Educational Research*, 2019(80), 25-38. https://doi.org/10.14689/ejer.2019.80.2

Fajri, N. (2024). Systematic literature review : dampak teknologi pendidikan terhadap pengembangan keterampilan berpikir kritis, kreatif, dan kolaboratif pada pembelajaran matematika. *Jurnal Teknologi Pendidikan*, 4(1), 11-24. https://doi.org/10.37304/jtekpend.v4i1.12083

Fajrina, R. N. A. A., Handayanto, S. K., & Hidayat, A. (2018). Peran Model Project Based Learning dalam Kemampuan Berpikir Kreatif Kelas XI IPA melalui Materi Fluida Dinamis. *Jurnal Pendidikan: Teori, Penelitian, dan Pengembangan*, 3(3): http://dx.doi.org/10.17977/jptpp.v3i3.10625

Fauziah, C., Nuvitalia, D., & Saptaningrum, E. (2018). Model Project Based Learning (PjBL) Berbasis Lesson Study Terhadap Kemampuan Berpikir Kreatif Siswa SMA. *Jurnal Penelitian Pembelajaran Fisika, 9*(2). doi:https://doi.org/10.26877/jp2f.v9i2.3170

Firdaus, F. M., Surahman, E., & Makiyah, Y. S. (2022). Pengaruh Model Project Based Learning Terhadap Keterampilan Berpikir Kreatif Peserta Didik Dalam Pembelajaran Fisika Materi Momentum Dan Impuls. *Jurnal Penelitian dan Pembelajaran Fisika*, 13(2): 171-180. DOI: 10.26877/jp2f.v13i2.11850

Harizon, H. (2023). Application of pjbl model by utilizing natural materials chemistry to improve students' 4c skills. *Eduline Journal of Education and Learning Innovation*, 3(3), 479-483. https://doi.org/10.35877/454ri.eduline2060

Haswan, H. (2024). Analysis of students creative thinking abilities through project-based learning in environmental knowledge courses. *Jurnal Pijar MIPA*, 19(1), 33-36. https://doi.org/10.29303/jpm.v19i1.6328

Hermansyah, H., Gunawan, G., & Herayanti, L. (2017). Pengaruh Penggunaan Laboratorium Virtual Terhadap Penguasaan Konsep dan Kemampuan Berpikir Kreatif Siswa pada Materi Getaran dan Gelombang. *Jurnal Pendidikan Fisika Dan Teknologi*, 1(2), 97–102. https://doi.org/10.29303/jpft.v1i2.242

Kementerian Pendidikan dan Kebudayaan, 2020. Sekolah Penggerak dan Profil Pelajar Pancasila, link: https://sekolah.penggerak.kemdikbud.go.id/

Mamahit, J. A., Aloysius, D. C., & Suwono, H. (2020). Efektivitas Model Project-Based Learning Terintegrasi STEM (PjBL-STEM) terhadap Keterampilan Berpikir Kreatif Siswa Kelas X. *Jurnal Pendidikan: Teori, Penelitian, dan Pengembangan*, 5(9): 1264- 1289. http://dx.doi.org/10.17977/jptpp.v5i9.14034

Marwani, R., & Sani, A. R. (2020). Pengaruh Model Project Based Learning Berbasis STEM Terhadap Kemampuan Berpikir Kreatif Siswa Pada Materi Pokok Fluida Statis di Kelas XI SMA Negeri 4 Tebing. *Jurnal Inovasi Pembelajaran Fisika*, 8(2): 8-15. https://doi.org/10.24114/inpafi.v8i2.18678

Natalia, D. (2023). Development of project-based ipas module to increase students' learning creativity smkn 1 gedongtataan. *Jurnal Teknologi Pendidikan Jurnal Penelitian Dan Pengembangan Pembelajaran*, 8(4), 867. https://doi.org/10.33394/jtp.v8i4.9299

Noorhalida, N. (2024). Enhancing students' creative thinking skills in equilibrium and rotational dynamics through the implementation of project based learning modules. *Radiasi Jurnal Berkala Pendidikan Fisika*, 17(1), 49-57. https://doi.org/10.37729/radiasi.v17i1.4323

Nuraini, N., & Waluyo, E. (2021). Pengembangan Desain Instruksional Model Project Based Learning Terintegrasi Keterampilan Proses Sains Untuk Meningkatkan Literasi Sains. *Jurnal IPA dan Pembelajaran IPA*, 5(1): 101-111. DOI: https://doi.org/10.24815/jipi.v5i1.20145

Nurfa, N. N., & Nana, N. (2020). Pengaruh Model Project Based Learning Terintegrasi 21st Century Skills Terhadap Kemampuan Berpikir Kreatif Siswa SMA Fisika. *Jurnal Penelitian Pendidikan Fisika*, 5(2): 109-115. http://dx.doi.org/10.36709/jipfi.v5i2.11522

Priyambodo, M., Probosari, R., & Indriyanti, N. (2021). Hubungan kepercayaan diri dan adversity quotient dengan keterampilan berpikir kreatif siswa kelas viii pada materi gerak dan gaya. *Phenomenon Jurnal Pendidikan MIPA*, 11(2), 231-244. https://doi.org/10.21580/phen.2021.11.2.9544

Putri, L. T., Nuroso, H., & Khoiri, N. (2018). Efektivitas Model Pembelajaran Berbasis Proyek Project Based Learning) Terhadap Keaktifan Dan Kemampuan Berpikir Kreatif Siswa Kelas X SMA N 2 Semarang. *Jurnal Penelitian Pembelajaran Fisika*, 6(2). https://doi.org/10.26877/jp2f.v6i2.2590

Putri, Y. A., & Zulyusri, Z. (2022). Meta-Analisis Pengaruh Model Project Based Learning Terhadap Kemampuan Berpikir Kreatif Siswa pada Pembelajaran Biologi. *Bioeduca: Journal of Biology Education*, 4(2): 84-94. DOI: 10.21580/bioeduca.v4i2.11891

Saefullah, A., Suherman, A., Utami, R. T., Antarnusa, G., Rostikawati, D. A., & Zidny, R. Implemetation of PjBL-STEM to Improve Students' Creative Thinking Skills on Static Fluid Topic. *Jurnal Ilmu Pendidikan Fisika*, 6(2): 149-157. http://dx.doi.org/10.26737/jipf.v6i2.1805

Sahtoni, S., Suyatna, A., & Manurung, P. (2017). Implementation of student's worksheet based on project based learning (pjbl) to foster student's creativity. *International Journal of Science and Applied Science Conference Series*, 2(1), 329. https://doi.org/10.20961/ijsascs.v2i1.16738

Santyasa, I. W., Rapi, N. K., & Sara, I. W. W. (2020). Project based learning and academic procrastination of students in learning physics. *International Journal of Instruction*, 13(1), 489–508. https://doi.org/10.29333/iji.2020.13132a

Sari, W. P., Hidayat, A., & Kusairi, S. Keterampilan Berpikir Kreatif Siswa SMA dalam Pembelajaran Project Based Learning (PjBL) pada Materi Fluida Statis. *Jurnal Pendidikan: Teori, Penelitian, dan Pengembangan*, 3(6): 751-757. http://dx.doi.org/10.17977/jptpp.v3i6.11155

Sungkono, S. (2023). Effectiveness of project-based learning model on improving critical thinking skills and student creativity. *Daengku Journal of Humanities and Social Sciences Innovation*, 3(5), 859-863. https://doi.org/10.35877/454ri.daengku2063

Suratno, Komaria, N., Yushardi, Dafik, & Wicaksono, I. (2019). The Effect of Using Synectics Model on Creative Thinking and Metacognition Skills of Junior High School Students. *International Journal of Instruction*, 12(3), 133-150. https://doi.org/10.29333/iji.2019.1239a

Umam, H. I., & jiddiyyah, S. H. (2021). Pengaruh Pembelajaran Berbasis Proyek Terhadap Keterampilan Berpikir Kreatif Ilmiah Sebagai Salah Satu Keterampilan Abad 21. *BASICEDU: Research & Learning in Elementary Education*, 5(1): 350-356. DOI: https://doi.org/10.31004/basicedu.v5i1.645

Usmeldi, U. (2019). The effect of project-based learning and creativity on the students' competence at vocational high schools. *Proceedings of the 5th UPI International Conference on Technical and Vocational Education and Training (ICTVET 2018)*. https://doi.org/10.2991/ictvet-18.2019.4

Utami, Z. L., Bukit, N., Simanjuntak, M. P., & Motlan, M. (2019). Pengaruh Model Project Based Learning terhadap Keterampilan Berpikir Kreatif pada Materi Fluida Dinamis di SMA. *Jurnal Pendidikan Fisika*, 8(2): 97-101. https://doi.org/10.22611/jpf.v8i2.14997

Widiarini, P., Pramada, I P. W. Y., & Mardana, I B.P. (2021). Pengaruh Model Pembelajaran Berbasis Proyek Berbantuan Lab Virtual terhadap Kreativitas Mahasiswa. *ORBITA: Jurnal Pendidikan dan Ilmu Fisika*, 7(1): 212-218. DOI: https://doi.org/10.31764/orbita.v7i1.4649

Widiarini, P., Rapi, N.K., Pramadi, I.P.W.Y., & Udayana, K.W. 2022. Development of project-based electronics practicum module with virtual lab to increase students' creativity. *Jurnal Penelitian Pendidikan IPA*, 8(3): 1135-1141. https://doi.org/10.29303/jppipa.v8i3.1364

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), 3-2

Winarko, G. (2024). Project-based learning with scratch to improve students' creative thinking ability: systematic literature review. Griya Journal of Mathematics Education and Application, 4(2), 190-196. https://doi.org/10.29303/griya.v4i2.440

Zarate, D., Stavropoulos, V., Ball, M., de Sena Collier, G., & Jacobson, N. C. (2022). "Exploring the digital footprint of depression: A PRISMA systematic literature review of the empirical evidence": Correction. *BMC Psychiatry*, 22, Article 530. https://doi.org/10.1186/s12888-022-04153-1