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Enhancing Students' Creative Thinking through Project-Based Physics E-Modules

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Abstract

The creative thinking ability of students in physics learning is still relatively low, especially because the strategies, methods or learning media are less varied and do not involve students actively in the learning process. This study aims to determine the effect of project-based learning physics e-modules on students' creative thinking abilities. This study is a pre-experimental study using a one group pretest-posttest design. The sample consisted of 90 students selected using the purposive sampling technique. This project-based learning physics e-module product is effective in improving students' creative thinking abilities as seen from the results of the n-gain test to the three schools, an average n-gain of 0.71 was obtained in the high category. Based on the interpretation of the effectiveness of the n-gain value of 71% obtained, it is classified into the fairly effective category. And seen from the hypothesis test, it produces sig. <0.05. This study has implications for the effectiveness of students' creative thinking abilities because of the influence of project-based learning physics e-modules.

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INTRODUCTION

Physics education today follows the 21st-century paradigm, aiming to develop students' critical thinking, creativity, collaboration, and communication skills, enabling them to become high-quality human resources (Hidayat et al., 2019; Rosnaeni, 2021). Physics is a branch of science that plays a crucial role in life and technology (Pratiwi et al., 2019). One of its key aspects is fostering creative thinking skills through problem-solving exercises, rather than merely learning physics formulas (Ridwan et al., 2021).

Creative thinking skills are essential for today's generation. These skills need to be developed to anticipate rapid changes in life, allowing individuals to compete effectively. Additionally, creative thinking is crucial in the learning process so that students become accustomed to solving various problems they encounter (Rahmawati, 2022). Creative thinking skills have several indicators, including fluency, flexibility, originality, and elaboration (Anisa et al., 2023; Almeida et al., 2008; Fiteriani et al., 2021). Through creative thinking, students can develop an understanding or generate ideas to find new solutions to problems. This thinking process also fosters students' curiosity in problem-solving (Mardhiyana & Sejati, 2016). However, students' creative thinking skills remain low. Some contributing factors include teacher-centered learning strategies (Suharno et al., 2022). Teachers often deliver material through lectures and then assign problem-based tasks

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or evaluations, while students act as passive listeners. Additionally, teachers frequently use textbooks and worksheets that do not sufficiently support the enhancement of creative thinking skills (Hartati et al., 2021).

One approach to improving creative thinking skills is through the Project-Based Learning (PjBL) model (Diastuti et al., 2024; Yamin et al., 2020; Yuberti et al., 2024). Project-Based Learning is an instructional model that helps students explore, assess, interpret, synthesize, and gather information from various sources to create a creative product. This learning model applies real-life problem-solving as a means to develop creativity and problem-solving skills (Maysyaroh & Dwikoranto, 2021). By engaging in project assignments, students become more actively involved in the learning process (Haryanti & Saputra, 2019).

However, the success of PjBL in fostering creativity heavily depends on the teaching materials used. One instructional material that can effectively support PjBL implementation is the e-module. E-modules assist teachers in facilitating student learning (Asrial et al., 2020; Diani et al., 2021; Yunita et al., 2024). An e-module is an electronic module that operates on a computer. It can display text, images, animations, and videos in an electronic format. Technological advancements have also made it possible for e-modules to be accessed via smartphones (Diani et al., 2019; Laili et al., 2019). Another advantage of e-modules is their ability to reduce paper usage in the learning process (Zinnurain, 2021). This provides an alternative learning medium that students can access flexibly, anytime and anywhere.

PjBL-based e-modules offer various learning experiences by shaping students' roles and responses to different ideas while solving problems, ultimately improving their learning outcomes and creating a conducive learning environment. One effective instructional method is PjBL-based learning, where e-modules are equipped with materials, images, and videos that make learning resources more accessible and easier to understand. PjBL-based learning has significant potential to make learning experiences more engaging and meaningful for students while enhancing their scientific performance in lessons. Meanwhile, teachers serve primarily as facilitators (Sukackė et al., 2022) and mediators (Amaral, 2021).

Research on Project-Based Learning, whether using e-modules or just the learning model itself, has been widely conducted. Some examples include The Development of a Project-Based Learning Physics Experiment E-Module (Hayati & Fauziah, 2023), Local Wisdom-Based E-Module with Project-Based Learning Model: Enriching Energy Topic in Physics Learning (Widayanti et al., 2022), Development of a Project-Based Learning Module on Static Fluids to Enhance Students' Creativity in High School Physics (Novianto et al., 2018), and The Effect of Project-Based Learning on Students' Creative Thinking Skills in Biology (Altatri & Ardi, 2024). However, among these studies, there has been no research specifically focusing on the impact of a physics e-module based on Project-Based Learning (PjBL) on students' creative thinking skills. Therefore, this study aims to investigate the effect of implementing a PjBL-based physics e-module on enhancing students' creative thinking skills.

METHOD

This study is a pre-experimental research with a one-group pretest-posttest design (Sugiyono, 2015) aimed at measuring the impact of using a Project-Based Learning (PjBL)-based physics e-module on students' creative thinking skills. The research subjects consisted of 90 students from three schools: SMAN 1 and SMAN 2 Gedong Tataan, and SMA Persada Bandar Lampung. The participants were selected through purposive sampling based on their previous academic performance and recommendations from physics teachers.

The instruments used in this study included a creative thinking skills test, observation sheets, and structured interviews. The creative thinking skills test measured four indicators: fluency, flexibility, originality, and elaboration, using project-based questions that encouraged innovative solutions to physics problems. The observation sheets were used to monitor students' engagement during learning sessions and the implementation of the PjBL-based e-module, focusing on active participation, teamwork, and responses to project challenges. Additionally, structured interviews were conducted to gather feedback from students and teachers regarding the effectiveness of the e-module in enhancing creativity.

The collected data were analyzed using several statistical techniques. Descriptive analysis was employed to describe the pretest and posttest scores and data distribution. The Shapiro-Wilk normality test was conducted to ensure that the pretest and posttest data followed a normal distribution. The N-Gain test was used to measure the improvement in creative thinking skills after using the e-module, categorized as high ($g > 0.7$), moderate ($0.3 < g \leq 0.7$), or low ($g \leq 0.3$). Additionally, a Paired Sample T-Test was conducted to determine the significance of the differences between pretest and posttest results.

RESULTS AND DISCUSSION

The measurement of students' creative thinking skill development was conducted through pretest and posttest assessments. The pretest results provide an initial overview of students' creativity levels across several indicators, while the posttest results indicate improvements after the learning intervention. The analysis of the pretest results from students in the three schools involved in the study is presented in Table 1.

Table 1. Pretest Results

School	Average Creative Thinking Ability (%)			
	Fluency	***Flexibility***	***Originality***	***Elaboration***
SMAN 1	47%	41%	42%	42%
SMAN 2	51%	50%%	46%	42%
SMA Persada	51%	43%	39%	42%

Based on Table 1, the pretest results indicate that students' creative thinking ability is still within the "moderately creative" category, with an overall average of 44%. When analyzed by each indicator, fluency has the highest average (49%), followed by flexibility (44%), originality (42%), and elaboration (41%). This data suggests that students are relatively more capable of generating various ideas (fluency), but they still struggle with developing ideas that are more flexible, original, and detailed. Additionally, there are differences in scores between schools, although the overall results remain relatively similar. The low pretest scores indicate that students are not yet accustomed to learning activities that stimulate their creativity. Therefore, an intervention in the form of more innovative learning, such as the use of a Project-Based Learning (PjBL)-based e-module, is necessary.

The following are the average posttest scores of students' creative thinking abilities after learning with the PjBL-based physics e-module to enhance their creative thinking skills, as shown in Table 2.

Table 2. Posttest Results

School	Average Creative Thinking Ability (%)			
	Fluency	***Flexibility***	***Originality***	***Elaboration***
SMAN 1	91%	83%	77%	82%
SMAN 2	86%	85%	79%	82%
SMA Persada	88%	89%	88%	89%

The posttest results presented in Table 2 show a significant improvement in students' creative thinking abilities after using the Project-Based Learning (PjBL)-based e-module. The average posttest score reached 84%, which falls into the creative category. This improvement is evident in each indicator, where fluency increased from 49% to 88%, flexibility from 44% to 86%, originality from 42% to 80%, and elaboration from 41% to 81%.

When comparing between schools, SMAN 1 showed the highest improvement in fluency (91%), indicating that students became more fluent in generating ideas. Meanwhile, SMAN 2 exhibited more balanced development, particularly in flexibility (85%) and elaboration (82%), demonstrating that students improved in thinking flexibly and detailing their ideas. SMA Persada showed consistent growth across all indicators, especially in originality (88%), reflecting students' ability to generate unique and innovative ideas.

Overall, these results indicate that the PjBL-based e-module is effective in enhancing students' creative thinking skills. The increase across all indicators suggests that this learning method helps students generate ideas fluently, think flexibly to solve problems, create original ideas, and elaborate on concepts more effectively. To quantitatively measure the effectiveness of this improvement, an N-Gain test was conducted to assess the increase from pretest to posttest. The analysis results are presented in Table 3.

Table 1. N-Gain Test Results

No	Indikator	Rata-rata nilai N-*gain* per indikator	Kategori
1	*Fluency*	0,77	High
2	*Flexibility*	0,75	High
3	*Originality*	0,66	Sedang
4	*Elaboration*	0,68	Sedang
Rata-Rata		**0,71**	**Tinggi**

Based on the N-Gain analysis, the average score for fluency reached 0.77, followed by flexibility (0.75), originality (0.66), and elaboration (0.68).

Across the three schools (SMAN 1 Gedong Tataan, SMAN 2 Gedong Tataan, and SMA Persada Bandar Lampung), the average N-Gain score was 0.71, which, when converted to percentage, equals 71%, falling into the high category. According to the effectiveness interpretation of N-Gain scores, 71% is classified as moderately effective. To ensure that the students' creative thinking ability test results can be analyzed using parametric statistical methods, a normality test was conducted. This test determines whether the pretest and posttest data distribution is normal. The results of the Shapiro-Wilk normality test are presented in Table 4.

Table 2. Normality Test Results

Tests of Normality

	Shapiro-Wilk		
	Statistic	df	Sig.
Pre-Test	.978	90	.125
Post-Test	.973	90	.061

Based on the Shapiro-Wilk normality test results, the significance value for creative thinking ability in the pretest is 0.125, and for the posttest, it is 0.061. Since both values are greater than 0.05, it can be concluded that the data is normally distributed. To determine the significant difference between the pretest and posttest results, a Paired Sample T-Test was conducted, as shown in Table 5.

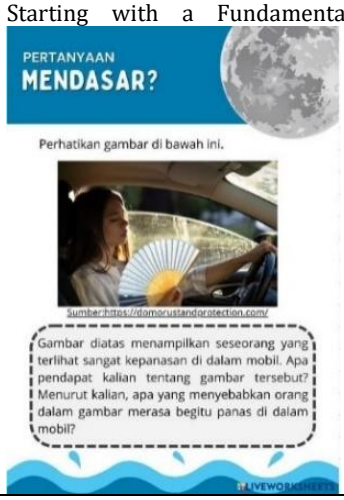
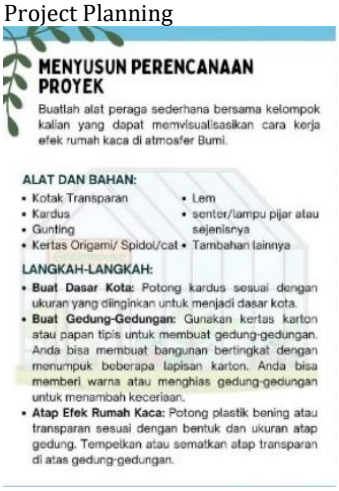
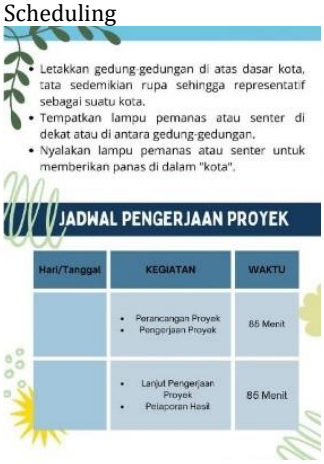
Table 3. Paired Sample T-Test Results

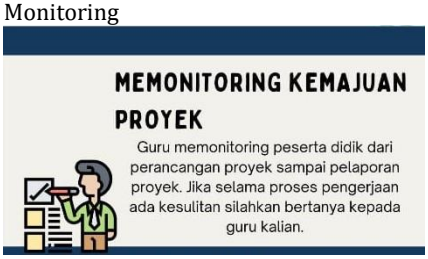
Paired Samples Test

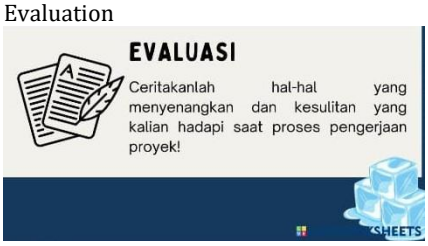
		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	PRETEST - POSTTEST	-15.74444	4.44836	.46890	-16.67614	-14.81275	-33.578	89	.000

Based on the Paired Sample T-Test results, the mean difference between the pretest and posttest scores is -15.7444, with a significance value of 0.000 ($p < 0.05$). This result indicates that the use of the PjBL-based physics e-module has a significant effect on improving students' creative thinking abilities. To further analyze the relationship between the Project-Based Learning (PjBL) syntax and the creative thinking ability indicators, refer to Table 6.

Table 4. Relationship Between PjBL and Creative Thinking Ability Indicators

No	Sintak PjBL	Indikator	Keterkaitan
1	Starting with a Fundamental Question 	Fluency	Helps students develop fluency in generating various ideas, perspectives, and diverse, relevant solutions.
2	Project Planning 	• Fluency • Flexibility • Original	Fluency: The e-module provides various resources, project examples, and guidelines that can stimulate the emergence of numerous ideas from students. Through interactive materials and structured activities, students are encouraged to generate multiple ideas in project planning, thereby enhancing their fluency in idea generation. Flexibility: During the planning stage, the e-module helps students explore various approaches and solutions for their projects. By offering options for tools, materials, and step-by-step instructions, students are encouraged to think flexibly, shift perspectives, and use different methods to solve project-related problems. Originality: The e-module provides space for students to develop unique and original ideas in their projects. For example, through creativity-challenging tasks or collaborative features that facilitate brainstorming, the e-module encourages students to create solutions and designs that have never existed before.
3	Scheduling 	Fluency	The e-module acts as a facilitator that helps students determine their project planning time smoothly and systematically.

4	Monitoring  	• Fluency • Flexibility • Original • Elaboration	Fluency: The e-module provides real-time project monitoring features, such as automated checklists. These features help students generate many ideas for adjusting or improving their projects based on current progress. The ability to update and modify projects quickly facilitates idea fluency in responding to changes or challenges during the project. Flexibility: The e-module allows students to explore various options for overcoming obstacles during the project. Features like rescheduling, customizable resource allocation, or alternative solutions encourage flexible thinking. Students can adjust their project approach when issues arise, enhancing their adaptability to dynamic situations. Originality: While monitoring progress, students can reflect on and assess their creativity throughout the project. They can review and refine original ideas based on project findings, fostering the development of unique and innovative concepts to enhance their work. Elaboration: The e-module supports students in elaborating on or expanding their initial ideas by providing tools for documenting project details more comprehensively. Features such as automated reports or multimedia integration enable them to expand and simplify project aspects, explain each step more thoroughly, and enhance overall project development.
5	Presentation and Publication of Results  	• Fluency • Flexibility • Original • Elaboration	Fluency: Presenting results allows students to express many ideas fluently, sharpening their ability to communicate project outcomes effectively. Flexibility: During presentations and publications, students are required to think flexibly, view problems from different perspectives, and provide alternative solutions in their presentations. Originality: The process of publishing results requires students to demonstrate originality in the products or solutions they present. They must showcase unique and creative ideas that offer novelty or differentiation in their final project outcomes. Elaboration: In presentations, students must be able to elaborate on their ideas in-depth, explain complex details, and provide a comprehensive explanation of how they achieved their project results.

6	Evaluation 	• Fluency • Flexibility	Fluency: In the evaluation stage, students are encouraged to reflect on their project processes and outcomes. Fluency skills are developed as students can express various responses or ideas smoothly about what they have learned, the challenges they faced, and the solutions they adopted during the project. Evaluation provides an opportunity for students to speak freely and share diverse perspectives on their learning experiences. Flexibility: During evaluation, students are also expected to think flexibly, adjusting their thoughts based on received criticism, suggestions, or feedback. They must be able to consider different approaches or new ways to solve problems encountered during the project and remain open to changes and improvements.

The significant improvement in posttest results indicates that the use of a PjBL-based e-module helps students develop their creative thinking skills. The PjBL model enables students to be more active in designing projects, conducting explorations, and finding innovative solutions (Nastiti et al., 2023). Other studies have found that PjBL is effective in enhancing students' creative thinking skills in the context of Newton's laws of motion (Safitri & Suparwoto, 2018). However, compared to previous studies that focused solely on the PjBL aspect without incorporating digital technology, the findings of this study suggest that combining PjBL with a digital-based e-module yields more optimal results in enhancing students' creativity. The advantage of e-modules lies in their ability to present material interactively with animations, videos, and simulations, making learning more engaging for students (Dewi et al., 2019; Venkatesan et al., 2023).

Although this study shows positive results, there are several limitations to consider, such as time constraints due to the need to align with other physics topics, student absences due to illness, permission, or truancy, and a lack of discipline in bringing tools and materials for project work. Future research is recommended to explore the impact of PjBL-based physics e-modules on other skills, such as collaborative skills, problem-solving abilities, or digital literacy.

CONCLUSION

The physics e-module based on Project-Based Learning (PjBL) is effective in enhancing students' creative thinking skills, as evidenced by the N-Gain test results from three schools, which showed an average N-Gain of 0.71, categorized as high. Based on the interpretation of the effectiveness of the 71% N-Gain score, it falls into the moderately effective category. Furthermore, the hypothesis test resulted in a significance value (sig.) of < 0.05, indicating a significant difference in students' creative thinking skills before and after using the PjBL-based physics e-module. Future research can explore the implementation of PjBL-based physics e-modules in improving other skills, such as critical thinking, collaboration, or problem-solving. Additionally, further analysis of the e-module's effectiveness across various physics topics and its impact on students' motivation and engagement would be an interesting area of study. The integration of other technologies to support project-based learning could also be investigated to further enrich educational innovations.

REFERENCES

Almeida, L. S., Prieto, L. P., Ferrando, M., Oliveira, E., & Ferrándiz, C. (2008). Torrance test of creative thinking: The question of its construct validity. *Thinking Skills and Creativity*, *3*(1), 53–58. https://doi.org/10.1016/j.tsc.2008.03.003

Altatri, A., & Ardi, A. (2024). Pengaruh model pembelajaran project based learning (PjBL) terhadap keterampilan berpikir kreatif peserta didik dalam pembelajaran biologi. *Jurnal Pendidikan*

Tambusa, *8*(1), 2442–2452.

Amaral, J. A. A. do. (2021). Using project-based learning to teach project-based learning: lessons learned ,. *Pro-Posições*, *32*, 1–21. https://doi.org/10.1590/1980-6248-2018-0135en

Anisa, N., Hijriyah, U., Diani, R., Fujiani, D., & Velina, Y. (2023). Project Based Learning Model: Its Effect in Improving Students' Creative Thinking Skills. *Indonesian Journal of Science and Mathematics Education*, *6*(1), 73–81. https://doi.org/10.24042/ijsme.v6i1.12539

Asrial, A., Syahrial, S., Maison, M., Kurniawan, D. A., & Piyana, S. O. (2020). Ethnoconstructivism e-module to improve perception, interest, and motivation of students in class V elementary school. *JPI (Jurnal Pendidikan Indonesia)*, *9*(1), 30. https://doi.org/10.23887/jpi-undiksha.v9i1.19222

Dewi, Y. N., Masril, M., Naf'an, E., Hendrik, B., Veri, J., Munawwaroh, K., Silfia, E., & Widyatama, A. (2019). The development of e-module english specific purpose based on computer application for vocational high school students. *Journal of Physics: Conference Series*, *1364*(1), 012043. https://doi.org/10.1088/1742-6596/1364/1/012043

Diani, R., Kesuma, G. C., Diana, N., Yuberti, Anggraini, R. D., & Fujiani, D. (2019). The Development Of Physics Module With The Scientific Approach Based On Islamic Literacy. *Journal of Physics: Conference Series*, *1155*(1), 012034. https://doi.org/10.1088/1742-6596/1155/1/012034

Diani, R., Yanti, Y., Hartati, N. S., Fujiani, D., Hasanah, I. F., & Alamsyah. (2021). Islamic Literacy-Based Physics E-Module with STEM (Science, Technology, Engineering, and Mathematics) Approach. *Journal of Physics: Conference Series*, *1796*(1), 012098. https://doi.org/10.1088/1742-6596/1796/1/012098

Diastuti, K., Diani, R., Saregar, A., Anugrah, A., & Fitri, M. R. (2024). Blended Project-Based Learning Model on 21st Century Skills: A Qualitative Content Analysis. *Journal of Philology and Educational Sciences*, *3*(1), Article 1. https://doi.org/10.53898/jpes2024315

Fiteriani, I., Diani, R., Hamidah, A., & Anwar, C. (2021). Project-based learning through STEM approach: Is it effective to improve students' creative problem-solving ability and metacognitive skills in physics learning? *Journal of Physics: Conference Series*, *1796*(1), 012058. https://doi.org/10.1088/1742-6596/1796/1/012058

Hartati, H., Fahruddin, F., & Azmin, N. (2021). Penerapan pembelajaran berbasis masalah mata pelajaran IPA terhadap kemampuan berpikir kreatif dan hasil belajar siswa. *JISIP (Jurnal Ilmu Sosial Dan Pendidikan)*, *5*(4), 1770–1775. https://doi.org/10.58258/jisip.v5i4.2574

Haryanti, Y. D., & Saputra, D. S. (2019). Instrumen penilaian berpikir kreatif pada pendidikan abad 21. *Jurnal Cakrawala Pendas*, *5*(2), 58–64. https://doi.org/10.31949/jcp.v5i2.1350

Hayati, P., & Fauziah, R. N. (2023). Pengembangan e-modul eksperimen fisika berbasis project based learning. *Journal on Education*, *05*(03), 10728–10734.

Hidayat, R., Ag, S., & Pd, M. (2019). *Ilmu pendidikan "Konsep, teori dan aplikasinya"* (C. Wijaya & Amiruddin (eds.); Pertama). Lembaga Peduli Pengembangan Pendidikan Indonesia (LPPPI).

Laili, I., Ganefri, & Usmeldi. (2019). Efektivitas pengembangan e-modul project based learning pada mata pelajaran instalasi motor listrik. *Jurnal Imiah Pendidikan Dan Pembelajaran*, *3*(3), 306–315.

Mardhiyana, D., & Sejati, E. O. W. (2016). Mengembangkan kemampuan berpikir kreatif dan rasa ingin tahu melalui model pembelajaran berbasis masalah. *PRISMA, Prosiding Seminar Nasional Matematika*, *1*(1), 672–688.

Maysyaroh, S., & Dwikoranto. (2021). Kajian pengaruh model project based learning terhadap keterampilan berpikir kreatif peserta didik pada pembelajaran fisika. *Jurnal ORBITA: Jurnal Kajian, Inovasi, Dan Aplikasi Pendidikan Fisika*, *7*(2), 110–117.

Nastiti, L. R., Sunarno, W., Saputro, S., Sukarmin, S., Chusni, M. M., & Qamariyah, Z. (2023). Project-based learning's effectiveness in teaching science creative thinking capabilities: Meta-analysis. *AIP Conference Proceedings*, 100007. https://doi.org/10.1063/5.0159781

Novianto, N. K., Masykuri, M., & Sukarmin, S. (2018). Pengembangan modul pembelajaran fisika berbasis proyek (project based learning) pada materi fluida statis untuk meningkatkan kreativitas belajar siswa kelas X SMA/MA. *INKUIRI: Jurnal Pendidikan IPA*, *7*(1), 81. https://doi.org/10.20961/inkuiri.v7i1.19792

Pratiwi, E. D., Latifah, S., & Mustari, M. (2019). Pengembangan media pembelajaran fisika development of physical learning media using Videoscribe Sparkol. *Indonesian Journal of*

Science and Mathematics Education, 2(3), 303–309.

Rahmawati, I. (2022). Mengembangkan keterampilan berpikir kreatif calon guru fisika melalui model project based e-learning. *Jurnal Ilmiah Pendidikan Fisika*, *6*(2), 283. https://doi.org/10.20527/jipf.v6i2.4158

Ridwan, Y. H., Zuhdi, M., Kosim, K., & Sahidu, H. (2021). Pengembangan media pembelajaran interaktif berbasis model problem based learning untuk meningkatkan kemampuan berpikir kreatif fisika peserta didik. *ORBITA: Jurnal Kajian, Inovasi Dan Aplikasi Pendidikan Fisika*, *7*(1), 103. https://doi.org/10.31764/orbita.v7i1.3832

Rosnaeni, R. (2021). Karakteristik dan asesmen pembelajaran abad 21. *Jurnal Basicedu*, *5*(5), 4341–4350. https://doi.org/10.31004/basicedu.v5i5.1548

Safitri, A. D., & Suparwoto. (2018). Enhancing senior high school students' creative thinking skills using project based e-learning. *Journal of Physics: Conference Series*, *1097*, 012030. https://doi.org/10.1088/1742-6596/1097/1/012030

Sugiyono. (2015). *Metode penelitian kuantitatif, kualitatif dan R&D*. Alfabeta.

Suharno, S., Selviana, A. S., & Sunarno, W. (2022). The effectiveness of using physics module with problem-based learning to enhance critical and creative thinking skills. *Journal of Education Research and Evaluation*, *6*(1), 19–25. https://doi.org/10.23887/jere.v6i1.35476

Sukackė, V., Guerra, A. O. P. de C., Ellinger, D., Carlos, V., Petronienė, S., Gaižiūnienė, L., Blanch, S., Marbà-Tallada, A., & Brose, A. (2022). Towards active evidence-based learning in engineering education: A systematic literature review of PBL, PjBL, and CBL. *Sustainability (Switzerland)*, *14*(21). https://doi.org/10.3390/su142113955

Venkatesan, J., Manickam, N., Madasamy, B., Rajagopal, M. D., & Karthikeyan, A. K. (2023). The impact of patient-centric interactive e-module in pathology among medical undergraduates. *Medical Science Educator*, *33*(6), 1347–1358. https://doi.org/10.1007/s40670-023-01869-x

Widayanti, W., Sinensis, A. R., Firdaus, T., Effendi, E., & Sholikahah, A. U. (2022). Local wisdom-based e-module with project-based learning model: Enriching energy topic in physics learning. *Indonesian Journal of Science and Mathematics Education*, *5*(1), 77–85. https://doi.org/10.24042/ijsme.v5i1.11339

Yamin, Y., Permanasari, A., Redjeki, S., & Sopandi, W. (2020). 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

Yuberti, Diani, R., Suryani, Y., Latifah, S., Jamaluddin, W., & Widiawati, N. (2024). PjBL model with the STEAM approach: A solution to improve computational thinking ability. *AIP Conference Proceedings*, *3058*(1), 020003. https://doi.org/10.1063/5.0201264

Yunita, Y., Diani, R., Noperi, H., & Velina, Y. (2024). Development of interactive e-modules with stem approach using canva application to improve students' critical thinking ability in physics learning. *JINoP (Jurnal Inovasi Pembelajaran)*, *10*(2), Article 2. https://doi.org/10.22219/jinop.v10i2.32004

Zinnurain. (2021). Pengembangan e-modul pembelajaran interaktif berbasis flip pdf corporate edition pada mata kuliah manajemen diklat. *ACADEMIA : Jurnal Inovasi Riset Akademik*, *1*(1), 1–8.