



Journal of Educational Studies



2026-Volume 4, Issue 1, 9-18
<https://ejournal.baleliterasi.org/index.php/Jes>
DOI: 10.58218/jes.v4i1.2440 | e-ISSN 3031-4232

Enhancing Students' Creative Thinking Through Creative Problem Solving-Based Learning: Design and Implementation

^{1*}Baiq Fatmawati, ²Aulia Ida Zulfitri

^{1,2}Department of Biology Education, Faculty of Mathematics dan Science, Universitas Hamzanwadi, Jl. Cut Nyak Dien No.85, Pancor, Kec. Selong, East Lombok, West Nusa Tenggara 83611, Indonesia

*Corresponds email: baiq.fatmawati@hamzanwadi.ac.id

Article Info

Received: March 30, 2026

Revised: April 1, 2026

Accepted: April 14, 2026

Keywords:

Creative Problem Solving, creative thinking, biology learning, viruses, teaching module

Abstract

This study aimed to develop a Creative Problem Solving-based teaching module and to evaluate its effectiveness in enhancing students' creative thinking on the topic of viruses in senior high school biology. The study employed a development research design using the 4D model consisting of Define, Design, Develop, and Disseminate stages, followed by a quasi-experimental evaluation in classroom implementation. The participants were tenth-grade students of *Madrasah Aliyah Muallimin NWDI Pancor, Indonesia*. The experimental group consisted of 33 students, while the control group consisted of 37 students. Data were collected through expert validation sheets, questionnaires, and pretest-posttest assessments. The data were analyzed using descriptive statistics, independent samples *t*-test, normalized gain analysis, and Cohen's *d* effect size analysis. The findings showed that the experimental group achieved greater improvement than the control group. The posttest results indicated a significant difference between the two groups ($t = -5.11, p < 0.001$), with a large effect size (Cohen's $d = 1.24$). These findings suggest that the Creative Problem Solving-based teaching module has promising potential to support students' creative thinking in biology learning. However, the results should be interpreted within the context of the study setting and research design

To cite this article: Fatmawati, B., Zulfitri, A., I. (2026). Enhancing Students' Creative Thinking Through Creative Problem Solving-Based Learning: Design and Implementation. *Journal of Educational Studies*, 4(1), 9-18.

This article is licensed under a [Creative Commons Attribution-ShareAlike 4.0 International License](https://creativecommons.org/licenses/by-sa/4.0/) ©2026 by author/s

1. Introduction

Modern education requires students not only to master academic knowledge but also to develop higher-order thinking skills, including creative thinking. Creative thinking is one of the essential competencies in twenty-first-century education because it enables students to generate original ideas, explore alternative solutions, and respond effectively to complex challenges. In biology education, creative thinking is especially important because many biological concepts are abstract and closely connected to real-life phenomena that require analysis, interpretation, and problem solving. Science education, therefore, should not merely emphasize content mastery, but also integrate knowledge, skills, and attitudes to help students construct scientific understanding meaningfully. Zeidan and Jayosi (2015) emphasized that science learning should support the integration of scientific knowledge, process skills, and attitudes, while Kupers et al. (2019) argued that structured and open-ended tasks provide broader opportunities for students to demonstrate creativity than closed tasks. However, in practice, the development of students' creative thinking in biology learning remains a challenge. In many classrooms, learning activities still focus heavily

on memorization and reproduction of information rather than idea exploration and problem solving. Such conventional practices limit students' opportunities to think divergently and construct their own understanding.

Shieh and Chang (2014) reported that students who are mainly exposed to memorization-oriented learning tend to show limited creativity and weak problem-solving ability. Similarly, Kristanti et al. (2018) found that many student worksheets emphasize concept recall rather than providing opportunities for learners to construct knowledge independently and develop thinking skills. In science learning, this issue is particularly problematic because biology is closely related to real-world contexts and environmental issues that demand exploration, interpretation, and higher-order thinking (Kaya & Elster, 2018). Several studies conducted in international contexts have shown that innovative science learning approaches can improve students' creative and scientific thinking. Ariza et al. (2024) highlighted the importance of argumentation and process-oriented learning in science and mathematics education, while Luo et al. (2020) and Wahyu et al. (2020) emphasized that science education should foster scientific reasoning, literacy, and problem-solving skills. In the Indonesian context, however, the implementation of instructional strategies specifically designed to develop creative thinking in biology classrooms is still limited. Saptanno et al. (2019), for example, reported that the learning model applied in a senior high school in Ambon did not adequately support the demands of the curriculum and resulted in low levels of flexibility and originality in students' thinking. Fatmawati et al. (2021) also noted that classroom assessments often measure only lower cognitive levels, thereby providing insufficient opportunities for students to demonstrate creative thinking.

One instructional approach with strong potential to address this issue is Creative Problem Solving. Creative Problem Solving is a learning approach that guides students through identifying problems, generating alternative ideas, evaluating possible solutions, and implementing the most appropriate response in a creative and systematic way. In biology education, this approach can help students connect scientific concepts with authentic situations, thereby encouraging both conceptual understanding and creative idea generation. Guilford, as cited in Phaksunchai et al. (2014) and Sophonhiranraka et al. (2015), emphasized that problem-solving activities requiring divergent responses are essential for producing multiple possible solutions. In line with this view, Creative Problem Solving offers a learning environment in which students are encouraged to think fluently, flexibly, originally, and elaboratively when addressing scientific problems.

Although previous studies have reported the potential of Creative Problem Solving to improve students' higher-order thinking, limited attention has been given to the systematic development and evaluation of Creative Problem Solving-based teaching modules in senior high school biology learning, particularly on the topic of viruses. Previous studies have discussed problem-based learning strategies or the use of worksheets to enhance thinking skills, but fewer studies have systematically developed and tested a Creative Problem Solving-based teaching module for biology topics at the secondary school level. In addition, prior studies have not sufficiently addressed how such instructional materials can be designed and validated within the Indonesian educational context.

Therefore, this study aimed to develop a Creative Problem Solving-based teaching module and to evaluate its effectiveness in enhancing students' creative thinking abilities in biology learning. The topic of viruses was selected because it requires students not only to understand scientific concepts but also to relate them to authentic issues in everyday life. By integrating Creative Problem Solving into a structured teaching module, this study is expected to contribute to more interactive, student-centered, and creativity-oriented biology learning

2. Methods

2.1 Participants

For the limited trial, a single class, which consists of 27 students from class 2 of *Madrasah Aliyah* was used. The research subject refers to the participants involved in the study. In this case, the subject of the research includes 33 students in the experimental group and 37 students in the control group from the 10th-grade biology classes at *Madrasah Aliyah Muallimin NWDI Pancor*.

These students were selected as representatives to explore the impact of creative problem solving on their creative thinking skills in the context of biology, specifically focusing on the topic of viruses. The research object pertains to the specific focus or content being studied. In this study, the object of the research is the teaching module based on creative problem solving, designed to enhance students' creative thinking skills. The module was applied to the topic of viruses in biology, and its feasibility, effectiveness, and impact on students' creative thinking abilities were the primary focus of the research. The study also involved the evaluation of the module's design, implementation, and overall effectiveness in improving students' creative thinking

2.2 Data Collection

2.2.1 Instrument of Collecting Data

Data collection for this study was carried out using questionnaires to assess the feasibility of the creative problem solving -based teaching module, creative problem -based worksheets, and a creative thinking test, employing a pretest-posttest technique. The data collection technique in this study involved both quantitative and qualitative methods. Quantitative data were collected through pretest and posttest assessments to measure the improvement in students' creative thinking skills before and after the implementation of the creative problem-solving based teaching module. Additionally, questionnaires were administered to gather feedback from students, teachers, and experts regarding the feasibility and effectiveness of the module. For qualitative data, evaluations were conducted by two biology education experts to assess the content and design of the module, and students provided open-ended responses to share their experiences and perceptions of the creative problem solving -based learning approach. These data collection techniques allowed for a comprehensive analysis of the module's impact and effectiveness.

2.2.2 Techniques for Collecting Data

This research is a development study aimed at developing a teaching module based on creative problem solving to improve students' creative thinking skills on the topic of viruses. The research flow follows a modified version of the Thiagarajan et al. (1974) development model, which includes Define, Design, Develop, and Disseminate (see Figure 2). In the implementation of this development research, a One Group Pretest-Posttest Design is used for the limited trial, and a Quasi-Experimental Nonequivalent Pretest and Posttest Control-Group Design is employed for the wider trial of the study.

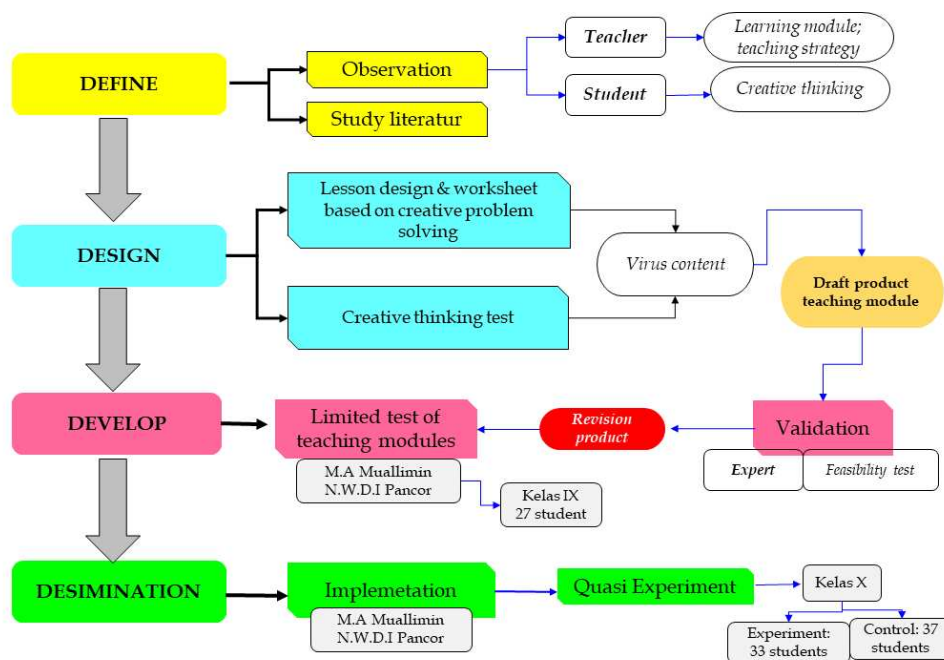


Figure 1: Research flow for developing problem-based biology teaching modules

2.3 Data Analysis

The data analysis techniques employed in this study included validity test of teaching modules, t-test, N gain, and Cohen's d effect test. Descriptive analysis was used to summarize and provide an overview of the pretest and posttest scores. This was followed by the **t-test** to examine significant differences between the experimental and control groups, specifically comparing the posttest scores. Additionally, Cohen's d was calculated to determine the effect size, providing insight into the magnitude of the treatment's impact on students' creative thinking skills

3. Results

3.1 Define Stage

At the define stage, needs analysis was conducted through classroom observations, informal interviews with biology teachers, and a review of existing teaching materials. The analysis indicated several major problems in biology learning on the topic of viruses. First, classroom instruction was still largely oriented toward memorization and factual recall. Second, teachers rarely used learning strategies specifically designed to foster creative thinking. Third, the available teaching materials did not sufficiently facilitate students' engagement in problem exploration, idea generation, or solution development. As a result, students showed limited ability to connect biological concepts with real-life situations and to produce varied and original responses during learning activities. These findings provided the basis for developing the Creative Problem Solving-based teaching module.

3.2 Design Stage

At the design stage, the Creative Problem Solving-based teaching module was systematically prepared. The design process involved three main components. First, the biology content to be developed was mapped, with a focus on the topic of viruses for tenth-grade students at the senior high school level. Second, the framework of the teaching module was developed, including learning objectives, Creative Problem Solving-based learning activities, student worksheets, teaching materials, and assessment components. Third, an evaluation instrument was designed to measure students' creative thinking abilities based on four indicators: fluency, flexibility, originality, and elaboration. The complete version of the teaching module was provided in the appendix.

3.3 Develop Stage

At the develop stage, the draft module was reviewed by two biology education experts to evaluate its content relevance, instructional clarity, and practical feasibility. The experts assessed 17 indicators using a validation rubric. The results showed that all indicators were categorized as relevant by both experts, resulting in a content validity coefficient of 1.00. Based on the predetermined criteria, this coefficient indicates very high content validity. Therefore, the module was considered suitable for implementation in the trial stage after minor revisions based on expert suggestions.

Teaching Module Validity Test: Product feasibility validation: The module has been validated by two biology education experts, and its feasibility for development was assessed. The goal of this evaluation is to gather feedback from the experts to refine the product and ensure its validity and practical feasibility. Below are the findings from both module evaluations.

Tabel 1. Validation Results of Teaching Modules

Matriks 2x2		Validator 1	
		Not relevant (score 1-2)	Relevant (score 3-4)
Validator 2	Not relevant (score 1-2)	0	0
	Relevant (score 3-4)	0	17

Based on the validity criteria for the instrument, which ranges from 0.8 to 1, this instrument has very high validity and is suitable for trial testing. When converted to the content validity coefficient criteria, it is evident that the resulting teaching module demonstrates a very high validity level. Therefore, it can be confidently stated that the creative problem-solving teaching module for enhancing students' creative thinking skills is officially recognized as valid.

3.4 Disseminate Stage

The disseminate stage involved the wider implementation of the developed module in two tenth-grade biology classes. One class consisting of 33 students was assigned as the experimental group and received instruction using the Creative Problem Solving-based teaching module, while the other class consisting of 37 students served as the control group and received conventional instruction. This stage was conducted to examine the effectiveness of the developed module in improving students' creative thinking abilities on the topic of viruses.

3.5 Descriptive Statistics of Students' Creative Thinking Scores

Descriptive statistical analysis was conducted to provide an initial overview of students' creative thinking scores in the pretest and posttest for both groups. The results included the mean, median, standard deviation, minimum score, and maximum score.

Table 2. Descriptive Statistical Analysis of the Implemented Teaching Module

Statistic	Experimental Group	Experimental Group	Control Group	Control Group
	Pretest	Posttest	Pretest	Posttest
Mean	9.39	19.79	10.32	15.68
Median	9.0	20.0	10.0	15.0
Standard deviation	1.12	3.63	1.56	3.04
Minimum	8.0	12.0	8.0	11.0
Maximum	12.0	34.0	14.0	22.0

The descriptive results indicate that both groups experienced improvement from pretest to posttest. However, the increase in the experimental group was substantially greater than that in the control group. The mean score of the experimental group increased from 9.39 to 19.79, whereas the control group increased from 10.32 to 15.68. These findings suggest that the Creative Problem Solving-based teaching module contributed more strongly to the improvement of students' creative thinking abilities.

3.6 Independent Samples *t*-Test Analysis

After the descriptive analysis, an independent samples *t*-test was conducted to determine whether there were significant differences between the experimental and control groups in both the pretest and posttest stages. The test used is the independent *t*-test with a significance level of 5% ($\alpha = 0.05$). This analysis was conducted on the pretest and posttest scores for the topic of viruses.

Table 3. *t*-test analysis results

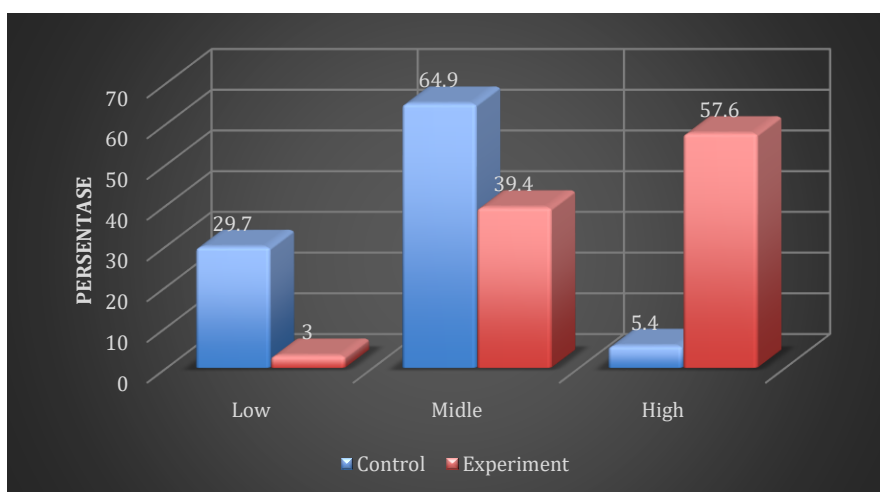
Content	Stage	<i>t</i>	<i>p</i> -value	Conclusion
Viruses	Pretest	2.89	0.0053	Significant

Viruses	Posttest	-5.11	0.0000	Significant
----------------	----------	-------	--------	-------------

The *t*-test results revealed a significant difference between the two groups in the pretest stage, indicating that the groups were not equivalent at the beginning of the study. In the posttest stage, the difference between the groups became more pronounced and remained statistically significant. The posttest result indicates that students who learned using the Creative Problem Solving-based teaching module achieved higher creative thinking scores than those who received conventional instruction. However, because the pretest difference was already significant, this result should be interpreted carefully, and the effectiveness claim should be supported by improvement analysis such as normalized gain and effect size.

3.7 Normalized Gain Analysis

To further examine the improvement in students' creative thinking abilities, a normalized gain analysis was conducted for both the experimental and control groups. The analysis showed that the experimental group achieved a greater improvement than the control group. This result indicates that the use of the Creative Problem Solving-based teaching module was more effective in enhancing students' creative thinking abilities on the topic of viruses.



Graph 1. N Gain creative thinking in control and experiment class

The descriptive analysis results show an increase in creative thinking scores for both groups, experimental and control. However, the most notable improvement was observed in the experimental group. This significant increase suggests that the creative problem-solving approach is more effective in encouraging students to optimally develop their creative thinking potential. This aligns with the view of **Treffinger (2004)**, who emphasized that creative problem-solving focuses on the systematic exploration of ideas to find creative solutions to complex problems. These findings are consistent with the study by **Fahrisa & Parmin (2022)**, which demonstrated that creative problem solving is effective in improving students' critical and creative thinking skills in science subjects.

3.8 Effect Size Analysis

In addition to the *t*-test, Cohen's *d* effect size analysis was conducted to determine the magnitude of the treatment effect. This test aims to determine the size of the effect (effect size) of the treatment given on students' creative thinking abilities. The Cohen's *d* value provides an indication of how strong the difference is between the two groups, with general categories being 0.2 (small effect), 0.5 (medium effect), and 0.8 or higher (large effect). Therefore, the Cohen's *d*

calculation strengthens the t-test findings while also providing practical information about the strength of the treatment effect in the context of learning.

Table 4. Result of cohen's d analysis

Content	<i>t</i> (<i>p</i> value)	Cohen's <i>d</i>	Interpretation
Viruses	-5.11 (<i>p</i> = 0.0000)	1.24	Large effect

The effect size analysis showed that the treatment produced a large effect on students' creative thinking abilities, as indicated by Cohen's $d = 1.24$. This finding means that the Creative Problem Solving-based teaching module had a strong practical impact on improving students' performance. These results are consistent with the study by Fatmawati et al (2022), which reported that all indicators of creative thinking significantly improved in the class with the creative problem-solving model. Helen & Kusdiwelirawan (2022) also found that creative problem solving not only affects learning outcomes but is superior to the direct instruction model in stimulating divergent thinking abilities. Luthfia (2024) reported that creative problem solving significantly strengthens the connections between creative thinking indicators in physics learning and enhances students' ability to generate original ideas

4. Discussion

The findings of this study demonstrate that the Creative Problem Solving-based teaching module was effective in improving students' creative thinking abilities on the topic of viruses. This effectiveness is reflected in the higher increase in posttest scores achieved by the experimental group compared to the control group. The descriptive analysis showed that students who learned through the Creative Problem Solving-based module demonstrated stronger improvement in creative thinking performance, indicating that the learning activities embedded in the module successfully encouraged students to generate ideas, explore alternative responses, and develop more creative solutions to biological problems.

The effectiveness of the Creative Problem Solving-based module may be explained by the nature of the learning process it promotes. The module does not merely present biological concepts for memorization, but actively engages students in identifying problems, generating multiple ideas, evaluating alternatives, and selecting the most appropriate solution. Such learning experiences are closely related to the core dimensions of creative thinking, particularly fluency, flexibility, and originality. In the context of the topic of viruses, these stages likely helped students connect abstract scientific concepts with authentic issues, making learning more meaningful and cognitively demanding. As a result, students were given greater opportunities to construct knowledge actively and express diverse responses, which may explain the stronger improvement observed in the experimental group.

The statistical findings further support this interpretation. The posttest results revealed a significant difference between the experimental and control groups, indicating that the implementation of the Creative Problem Solving-based module contributed positively to students' creative thinking abilities. In addition, the effect size analysis showed a large effect, which means that the treatment was not only statistically significant but also practically meaningful in educational settings. However, because the pretest scores were already significantly different, the findings should be interpreted with caution. Even so, the greater improvement shown by the experimental group, supported by the normalized gain and effect size results, indicates that the module had a meaningful contribution to students' progress.

The effectiveness of Creative Problem Solving found in this study is consistent with previous research highlighting the importance of student-centered and creativity-oriented learning. Fahrissa and Parmin (2022) reported that Creative Problem Solving can improve students' critical and creative thinking in science learning by encouraging them to consider multiple possible solutions. Similarly, Helen and Kusdiwelirawan (2022) found that Creative Problem Solving was more

effective than direct instruction in stimulating divergent thinking. In the present study, the module provided students with opportunities to identify problems, generate ideas, evaluate alternatives, and determine appropriate solutions in the context of biological content. This process appears to have strengthened students' fluency, flexibility, and originality in responding to learning tasks.

Another important implication of this study is that the development of creative thinking does not occur automatically through conventional instruction. The lower improvement observed in the control group suggests that traditional teaching approaches may not provide sufficient opportunities for students to think divergently or produce original responses. In contrast, the Creative Problem Solving-based module created a more active and flexible learning atmosphere in which students could engage with ideas more freely and systematically. This suggests that the quality of instructional materials plays an important role in determining how far students can develop their creative potential. Therefore, the use of well-designed teaching modules should be considered an important component of innovation in biology education.

Overall, this study provides empirical support for the integration of Creative Problem Solving into biology learning as an effective strategy for improving students' creative thinking abilities. The findings contribute to the growing body of literature on innovative science instruction, especially in the Indonesian educational context where research on the systematic development of Creative Problem Solving-based teaching modules is still limited.

5. Conclusions

This study concludes that the Creative Problem Solving-based teaching module was effective in enhancing students' creative thinking on the topic of viruses in senior high school biology learning. Students in the experimental group showed greater improvement than those in the control group, and the statistical analyses indicated a significant difference with a large effect size. These findings suggest that Creative Problem Solving-based learning can be used as a promising instructional strategy to promote students' creative thinking in biology education. However, this study was conducted within a specific educational context with a relatively limited sample size, and the quasi-experimental design did not involve fully equivalent groups at the beginning of the study. Therefore, the findings should be interpreted with caution. Future studies are recommended to involve larger samples, more equivalent participant groups, and broader educational settings to strengthen the generalizability of the results.

6. Declaration of Conflicting Interest

The authors declare that there is no conflict of interest regarding the publication of this article. The research, data analysis, and interpretation of the findings were conducted independently and were not influenced by any financial, institutional, or personal interests

7. Acknowledgments

This research was funded by Universitas Hamzanwadi through the Center for Research, Community Service, and Publication in 2025 under the collaborative research scheme for lecturers and students. The authors would like to express their sincere gratitude to the students and teachers of *Madrasah Aliyah Muallimin NWDI Pancor* for their participation and support throughout the study. The authors also thank the biology education experts for their valuable feedback during the development and validation of the teaching module.

8. References

- Ariza, M. R., Armenteros, A. Q., & Castro, A. E. (2024). Promoting critical thinking through mathematics and science teacher education: The case of argumentation and graphs interpretation about climate change. *European Journal of Teacher Education*, 47(1), 41–59. <https://doi.org/10.1080/02619768.2021.1961736>
- Fahriza, N., & Parmin. (2022). Creative Problem Solving learning to improve students' critical and creative thinking in science materials. *Journal of Environmental and Science Education*, 2(2), 98–105.

- Fatmawati, B. (2019). Study on students' ability of visual-spatial on general biology course. *Journal of Physics: Conference Series*, 1157(2), Article 022080. <https://doi.org/10.1088/1742-6596/1157/2/022080>
- Fatmawati, B. (2020). Creative problem solving: Implemented study in biology content. *Journal of Physics: Conference Series*, 1567, Article 042079. <https://doi.org/10.1088/1742-6596/1567/4/042079>
- Fatmawati, B., Ariandani, N., & Sasmita, M. (2021). Student's creative thinking ability with the lesson study design in biology content. *Jurnal Penelitian Pendidikan IPA*, 7(2), 287–292. <https://doi.org/10.29303/jppipa.v7i2.708>
- Fatmawati, B., Djalilah, S. R., & Wafiah, N. (2023). Developing worksheet based on Creative Problem Solving models. *Jurnal Penelitian Pendidikan IPA*, 9(11), 10364–10370. <https://doi.org/10.29303/jppipa.v9i11.5138>
- Fatmawati, B., Jannah, B. M., & Sasmita, M. (2022). Students' creative thinking ability through Creative Problem Solving-based learning. *Jurnal Penelitian Pendidikan IPA*, 8(4), 2090–2094. <https://doi.org/10.29303/jppipa.v8i4.1846>
- Fatmawati, B., Wazni, M. K., & Husnawati, N. (2021). The study of worksheets based on Creative Problem Solving for biology subjects. *Jurnal Penelitian Pendidikan IPA*, 7(4), 701–706. <https://doi.org/10.29303/jppipa.v7i4.831>
- Hebert, S., & Cotner, S. (2019). A comparison of nonmajors' and majors' incoming science process skills. *The American Biology Teacher*, 81(8), 554–560. <https://doi.org/10.1525/abt.2019.81.8.554>
- Kaya, V. H., & Elster, D. (2018). German students' environmental literacy in science education based on PISA data. *Science Education International*, 29(2), 75–87. <https://doi.org/10.33828/sei.v29.i2.2>
- Kristanti, F., Ainy, C., Shoffa, S., Khabibah, S., & Amin, S. M. (2018). Developing Creative Problem Solving-based student worksheets for transformation geometry course. *International Journal on Teaching and Learning Mathematics*, 1(1), 13–23. <https://doi.org/10.18860/ijtlm.v1i1.5581>
- Kupers, E., Wermser, A. L., McPherson, G., & Geert, P. (2019). Children's creativity: A theoretical framework and systematic review. *Review of Educational Research*, 89(1), 93–124. <https://doi.org/10.3102/0034654318815707>
- Lin, C. Y. (2017). Threshold effects of Creative Problem-Solving attributes on creativity in the math abilities of Taiwanese upper elementary students. *Education Research International*, 2017, 1–9. <https://doi.org/10.1155/2017/4571383>
- Luo, M., Wang, Z., Sun, D., Wan, H., & Zhu, L. (2020). Evaluating scientific reasoning ability: The design and validation of an assessment with a focus on reasoning and the use of evidence. *Journal of Baltic Science Education*, 19(2), 261–275. <https://doi.org/10.33225/jbse/20.19.261>
- Phaksunchai, M., Kaemkate, W., & Wongwanich, S. (2014). Research and development of a training package for developing Creative Problem Solving of undergraduate students. *Procedia - Social and Behavioral Sciences*, 116, 4824–4828. <https://doi.org/10.1016/j.sbspro.2014.01.1032>
- Pursitasari, I. D., Alfitriyani, N., & Kurniasih, S. (2022). Enhancing students' creative thinking skills through biotechnology module-based socio-scientific issues. *Jurnal Penelitian Pendidikan IPA*, 8(2), 939–948. <https://doi.org/10.29303/jppipa.v8i2.1438>
- Saptenno, A. E., Tuaputty, H., Rumahlatu, D., & Papilaya, P. M. (2019). The improvement of learning motivation and creative thinking skills of senior high school students through modified problem-based learning model. *Journal for the Education of Gifted Young Scientists*, 7(4), 1175–1194.
- Shieh, R. S., & Chang, W. (2014). Fostering students' creative and problem-solving skills through a hands-on activity. *Journal of Baltic Science Education*, 13(5), 650–661.
- Sophonhiranraka, S., Suwannathachote, P., & Ngudgratokec, S. (2015). Factors affecting Creative Problem Solving in the blended learning environment: A review of the literature.

- Procedia - Social and Behavioral Sciences, 174, 2130–2136.
<https://doi.org/10.1016/j.sbspro.2015.02.012>
- Thiagarajan, S., Semmel, D. S., & Semmel, M. I. (1974). Instructional development for training teachers of exceptional children. Leadership Training Institute/Special Education, University of Minnesota.
- Wahyu, Y., Suastra, I. W., Sadia, I. W., & Suarni, N. K. (2020). The effectiveness of mobile augmented reality assisted STEM-based learning on scientific literacy and students' achievement. *International Journal of Instruction*, 13(3), 343–356.
<https://doi.org/10.29333/iji.2020.13324a>
- Zeidan, A. H., & Jayosi, M. R. (2015). Science process skills and attitudes toward science among Palestinian secondary school students. *World Journal of Education*, 5(1), 13–24.
<https://doi.org/10.5430/wje.v5n1p13>