JPPIPA 11(4) (2025)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

Problem Solving Skill in Physics Learning: Systematic Literature Review

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Received: October 30, 2024
Revised: March 16, 2025
Accepted: April 25, 2025
Published: April 30, 2025

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DOI: 10.29303/jppipa.v11i4.9579

Abstract: A systematic literature review on problem solving skills in physics learning has been done. The purpose of this literature review is to discuss aspects that affect problem solving skills in physics and determine the proper learning method to improve problem solving skills in physics. The method used in writing this article is literature review. Literature was searched by accessing electronic databases online from Scopus. At the beginning of the search in the Scopus database using the keywords problem solving, physical education, students. 35 articles were obtained that were in accordance with the research topic, and limited publications for the last 5 years. Through this literature review, it was found that problem solving ability in physics learning is influenced by the relationship with the students themselves, teachers, and the school environment. The selection of effective learning models and media can improve problem solving skills in physics learning, such as the use of STEM-based Project Based Learning (PjBL) models, inquiry learning models, causal reasoning learning models, and the application of CPSPL (cooperative problem solving physics) models, as well as the use of module, web-based learning and interactive multimedia can improve student's problem solving skills.

Keyword: Problem Solving; Problem Solving Skills; Physic

Introduction

In this 21st century, the development of science and technology has progressed very rapidly in many aspects of life. With the progress in the Global Era, the quality of human resources directly or indirectly becomes a very important requirement to face these challenges. Quality human resources are obtained from the quality of educational outcomes such as efforts to improve the quality of education which is an important factor in determining the progress and success of national development (Istiyono et al., 2019).

Based on Permendikbud number 24 of 2016 concerning Core Competencies and Basic Learning Competencies in the 2013 Curriculum which states that understanding and applying factual, conceptual, procedural knowledge in science, technology, arts, culture, and humanities with insights into humanity, nationality, state, and civilization related to phenomena and occurrences, as well as applying procedural knowledge in specific fields of study in accordance with their talents and interests to solve problems (Alami et al., 2018). Problem solving is a thinking process. Problem solving in learning physics is the process of finding solutions to problems in physics (Abdillah et al., 2020; Yuliati et al., 2018). In addition, problem solving skills are important skills that must be developed in science learning (Sardi et al., 2018). Science process skills are considered to provide meaningful learning experiences for students because it helps students to achieve higher-order thinking and critical thinking (W. Kurniawan et al., 2019). The characteristics of problems contained in

How to Cite:
Nasir, M. H., Widiatmono, R., & Kuswanto, H. (2025). Problem Solving Skill in Physics Learning: Systematic Literature Review. *Jurnal Penelitian Pendidikan IPA*, *11*(4), 34–40. https://doi.org/10.29303/jppipa.v11i4.9579

basic physics courses span between well-structured and poorly structured problems (Sutarno et al., 2021).

Gök & Sılay, 2010 says problem solving is one of the main objectives of the physics subject. Problem solving skills address several important points for students (Shishigu et al., 2018). Student's skills in solving physics problems can be known from the understanding of concepts and through the stages of problem solving. There are four problem solving processes, which include understanding the problem, developing a plan, implementing the plan, and reviewing or evaluating (Yuliati et al., 2018). However, there are still many students who have low problem solving skills. The contributing factors could be the subject matter studied, the learning process in the classroom and the teacher's teaching pattern (Abdillah et al., 2020).

The development of problem-solving skills can be done by integrating them into the content of the learning instructions that are being designed. In the learning process, students' problem solving skills are trained through the use of various learning models (Yusal et al., 2020). According to Aweke (2017), the learning process using problem-based learning can increase students' motivation and problem-solving skills in learning physics (Aryani et al., 2019). Grouping students into two categories: skilled students and unskilled students in solving physics problems (Theasy et al., 2018). According to Arends (2012), the application of problem-solving-based learning can improve thinking skills. The skill of thinking can show that someone has formal reasoning (Manurung & Panggabean, 2020). Students' physics problem solving skills are measured using the Science Problem Solving Skills Assessment Sheet (SPSSAS) which has been declared valid and reliable (Sari et al., 2018). Therefore, it is needed to conduct a literature review on problem solving skills in physics, as well as learning methods that can improve problem solving skills in physics. Thus, the purpose of this literature review is to discuss various aspects that affect problem solving skills in physics and determine the appropriate learning method to improve problem solving skills in physics.

Method

This study uses a systematic literature review using the PRISMA method (Preferred Reporting Items for Systematic Reviews and Meta-analyses). Literature searches from electronic scientific databases were conducted based on the PRISMA method framework guidelines. This procedure is divided into four stages: (1) identification (2) Screening (3) Eligibility (4) Included. As presented in Figure 1.

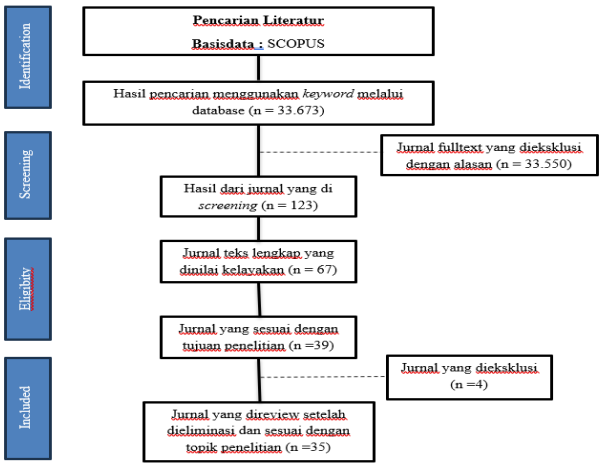

Figure 1. Systematic review flow with the PRISMA method

Literature searches were conducted by accessing electronic databases online from Scopus. At the beginning of the search in the Scopus database using the keywords problem solving, physical education, students found 102 articles. Then limit the publication time of the article with a range of years 2018-2023. As well as making other restrictions to get articles that match the keywords and the purpose of the intended research. After reviewing the articles that have been found, 35 articles are suitable for the research topic. The articles used were selected with a high level of suitability for review. The article analysis technique used is the mapping results from the VOSviewer application with the calculation of Co-Occurance. Co-Occurance analysis statistically maps research topics.

Result and Discussion

The research began with a search on the Scopus electronic database and found 102 articles on the topic of problem-solving skills. The number of publications of articles on the topic of problem-solving skills over the past six years can be seen in Figure 2.

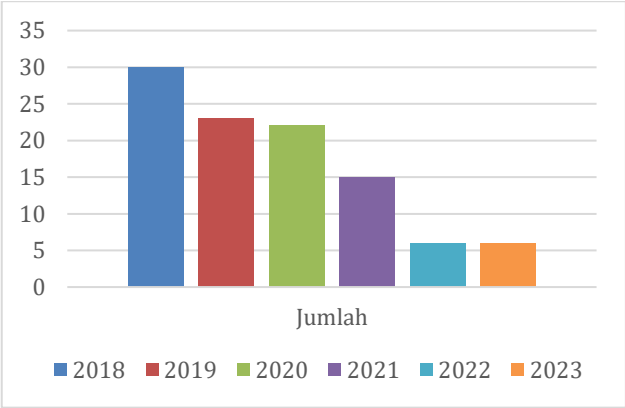

Figure 2. Number of Problem-Solving Skill Article Publications

In Figure 2 it is known that the highest number of publications was obtained in 2018 as many as 30 articles, and the fewest were in 2022 and 2023, namely 6 articles. From 2018 to 2023 there was a decrease in the publication of articles that raised the topic of Problem-Solving Skill. Problem-solving skills are complex and are one of the six main areas in physics education research (Parno et al., 2020). This decline resulted from the transition to the covid-19 pandemic. The most publications on the topic of Problem-Solving Skill were carried out by Indonesia, United State America, United Kingdom, Malaysia, and Hungary can be seen in Figure 3.

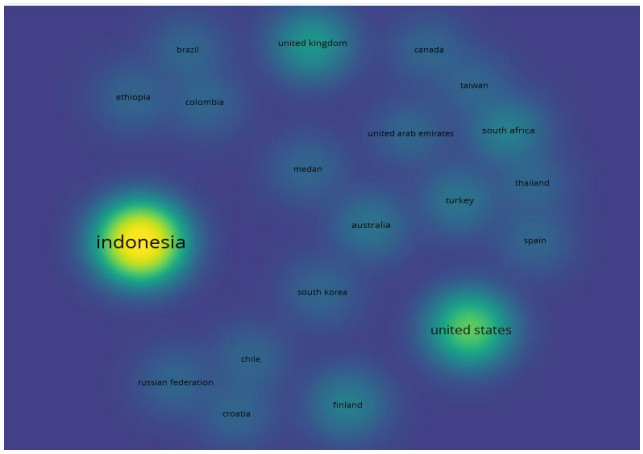

Figure 3. Vosviewer Density Visualization by Research Country

After that, the identification stage is carried out. The results obtained using the VOSviewer application.

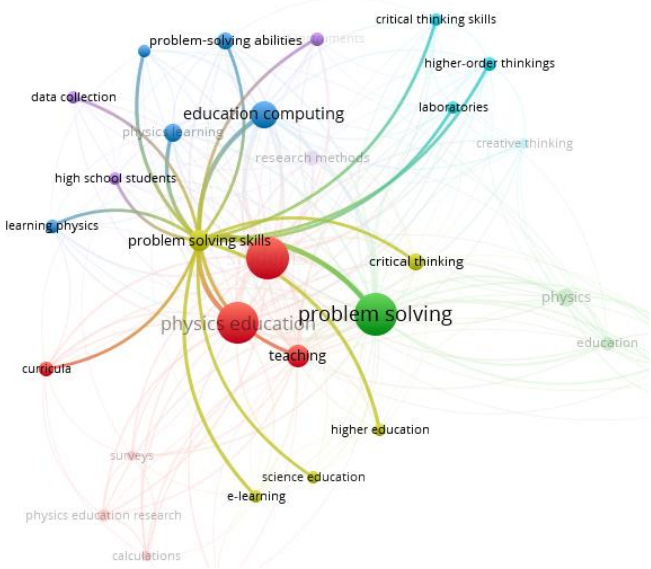

Figure 4. Network visualization map towards keyword

Figure 4 shows keywords that are interconnected with Problem solving skills. Based on the visualization map, there are several keywords that are sorted based on the distance of the closest relationship to the farthest distance relationship including: Physic education, problem solving, teaching, learning physics, high school student, education computing, curriculum, e-learning, science education, higher education, critical thinking, critical thinking skills, higher order thinking, laboratories, problem solving abilities, and data collection.

From the results of the review that has been made 35 articles are in accordance with the research topic with 3 main findings that can be classified as follows; 1) the learning model used, 2) media development. Media development. 3) Type of assessment. Learning models that can be used to improve problem solving skills include the STEM-based PjBL (Project based learning) model, the Inquiry model. Then the media development developed in previous studies to improve problem solving skills includes web development, interactive multimedia development and module development. And the last is the type of assessment used in testing problem solving skills including tests, and interviews. The tests used are multiple choice tests, essay tests, logical thinking ability tests (TOLT), Science Problem Solving Skills Assessment Sheet (SPSSAS), Attitudes and Approaches to Problem Solving (AAPS) survey, Physics Problem Solving Questionnaire (PPSQ), Decision making skills test, eye tracking, paper and pencil test, thinking aloud protocol (TAP).

Table 1. Learning Model

Article	Year	Title
(Yuliati et al., 2018)	2020	Building Scientific Literacy and Physics Problem Solving Skills through Inquiry-Based Learning for STEM Education
(Parno et al., 2020)	2020	The effect of project based learning-STEM on problem solving skills for students in the topic of electromagnetic induction
(Susanti et al., 2021)	2021	Analysis of problem-solving ability of physics education students in STEM-based project based learning
(Mustakim et al., 2020)	2020	Analysis of Students' Causal Reasoning in Physics Problem Solving
(Putri et al., 2019)	2019	The development of cooperative problem solving physics laboratory model on simple pendulum concept

Effective learning models to improve problem solving skills in physics learning, such as the STEM-based Project Based Learning (PjBL) model and the inquiry learning model. The inquiry learning model is one of the scientific learning models that focuses on student activeness to organize their knowledge, develop scientific science concept models, check the truth of the model, revise the model, and then apply it to solve the problem at hand (Ropika et al., 2019). Project-based

learning with STEM integration can improve students' problem-solving skills (Parno et al., 2020). STEM-based PjBL learning gives students the opportunity to solve real- life problems by applying science, math, and engineering. In addition, it allows students to solve problems through the creation of science-based products and designs. If students are accustomed to solving problems using the four STEM disciplines, then students will be more scientifically creative in solving problems, and can take full advantage of their potential (Susanti et al., 2021). From the results of research by Parno et al., (2020), it was concluded that students learning with PjBL-STEM had significantly higher problem solving skills compared to PjBL (control class) seen from the post-test scores of the experimental and control classes respectively of 57.78 and 41.63. Meanwhile, research by Susanti et al., (2021) shows that the problem solving skills of physics education students in STEM and PjBL-based learning is at a high level. And the results of research by Mustakim et al., (2020) show that causal reasoning has an important role in students when solving problems. The causal reasoning learning model can be used to improve problem solving skills. The application of the CPSPL (cooperative problem solving physics) model in physics learning can be used as an alternative model to improve students' problem solving skills (Putri et al., 2019).

In addition to the use of learning models, learning media also have an effect on problem solving skills. For example, the use of modules, web-based learning media and interactive multimedia. The use of web physics learning can help teachers and students in online learning and can be accessed anytime and anywhere (Aryani et al., 2019). Moreover, the use of interactive multimedia is also recommended. According to Kapi et al. in Manurung & Panggabean, (2020) said that interactive multimedia in the form of audio-visual media can present events in physics more realistically. So that student skills will increase, which in turn will be expected to encourage the emergence of student creativity. The next learning media that is mostly used is modules. Modules are teaching materials that are in accordance with the demands of the curriculum by considering the needs of students. Through this PBL module, students can apply and develop problem-solving skills through various forms of solution strategies. In particular, the application of this PBL-based physics module is expected to improve student learning outcomes (Isna et al., 2018). It is also expected that students have various ways to express their ideas from solving physics problems in their own way in different forms of expression to other students (Khoiri et al., 2019). The development of learning media is widely used as research, can be seen in table II.

Table 2 Development of Learning Media

Authors	Years	Title
(Dewi & Afrizon, 2020)	2020	Validity of handout development of physics education statistics course using a cooperative problem solving (CPS) model
(Darmaji et al., 2019)	2019	E-Module Based Problem Solving in Basic Physics Practicum for Science Process Skills
(Isna et al., 2018)	2018	Achievement of learning outcome after implemented physical modules based on problem based learning
(Putra et al., 2018)	2018	Planning Model of Physics Learning In Senior High School To Develop Problem Solving Creativity Based On National Standard Of Education
(Rizki et al., 2021)	2021	Electronic thermodynamics teaching materials based on authentic learning to practice students' problem-solving skills: Aspects of validity
(Wati et al., 2021)	2021	How to train problem-solving skills in physics using authentic learning
(Widodo et al., 2018)	2018	Analysis of expert validation on developing integrated science worksheet to improve problem solving skills of natural science prospective teachers
(Malkawi et al., 2019)	2019	Building an Interactive Mobile Application to Enhance Student's Problem Solving Skills in Higher Education Physics

Module development uses the ADDIE model (Analyze, Design, Develop, Implement, and Evaluate). The module development process only got to the third stage, namely development, with testing by experts who stated that the module met content validity and construction validity in terms of meeting basic competencies, content standards, process standards, and assessment standards (Dewi & Afrizon, 2020; Putra et al., 2018). There is also a development model that uses the 4D model (Define, Design, Develop, and Disseminate), with validation results in the valid category and feasible to use in physics learning to train student's problem solving skills (Wati et al., 2021). Another development model used is the ASSURE model. However, it only reaches the fourth stage, namely the utilization of learning materials. With the module categorized as valid and teaching materials that are said to be useful can then be used at the test phase of the class (Rizki et al., 2021).

Furthermore, the assessment of students' problem solving skills based on the synthesis results obtained several assessment instruments used, such as tests, questionnaires, interviews, and documentation. The test forms used are multiple choice tests and essay tests. Some of the tests used are logical thinking skills test (TOLT) (Manurung & Panggabean, 2020), Science

Problem Solving Skills Assessment Sheet (SPSSAS) (Sari et al., 2018), Attitudes and Approaches to Problem Solving (AAPS) survey (Balta & Asikainen, 2019), Physics Problem Solving Questionnaire (PPSQ) (Sirait et al., 2019), Decision making skills test (A. Kurniawan et al., 2019), eye tracking (Ibrahim & Ding, 2023), paper and pencil test, thinking aloud protocol (TAP), and semi-structured retrospective interview (ProTRet) (Murshed et al., 2021). Concept understanding in problem solving learning is optimized by providing formative assessment with online feedback. In conclusion, students from the experimental class were given the opportunity to elaborate the problem and choose alternative solutions. Therefore, students find alternative solutions from information gathering activities in experiments and discussions (Pratiwi et al., 2018). In the preparation of test instruments there are several studies using scaffolding (Nikat et al., 2020; Yusal et al., 2020). In addition, there are also tests whose instrument preparation uses the Rosengrant framework (Alami et al., 2018). While the RASCH model is used as data analysis using the Winsteps application (Marfu'i et al., 2019).

Conclusion

A systematic literature review on problem solving skills in physics learning has been completed. Factors that influence problem solving skills in physics learning are factors related to the students themselves, teachers, and the school environment. The selection of effective learning models and media can improve problem solving skills in physics learning, such as the use of STEM-based Project Based Learning (PjBL) models, inquiry learning models, causal reasoning learning models, and the application of CPSPL (cooperative problem solving physics) models, as well as the use of media modules, Web-based learning media and interactive multimedia can improve students' problem solving skills.

Author Contributions

Conceptualization, Muhammad Hilmi Nasir; methodology, Heru Kuswanto.; analysis, Muhammad Hilmi; writing—original draft preparation, Muhammad Hilmi Nasir; writing—review and editing, Muhammad Hilmi Nasir and Heru Kuswanto. All authors have read and agreed to the published version of the manuscript.

Funding

This research received no external funding.

Conflicts of Interest

The authors declare no conflict of interest.

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