ISSN (PRINT) : 2549-9955 ISSN (ONLINE): 2549-9963

JURNAL ILMIAH PENDIDIKAN FISIKA

https://ppjp.ulm.ac.id/journals/index.php/jipf/index

Development of Dynamic Problem-Solving Teaching Method in High School Physics Learning

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Abstract

High-order thinking skills are defined as a process in students that involves applying complex ideas, tends to have multiple possible answers, is open-ended, and involves elaborative thinking. To enhance students' thinking abilities, educators must be creative in creating a learning environment that supports learning objectives. Educators need effective learning strategies and should consider factors that can facilitate students. An ideal learning strategy to develop students' high-order thinking skills focuses on students. The purpose of research on dynamic problem-solving strategies is to understand how learners cope with evolving problems over time or in continuously changing learning environments. One such strategy developed is dynamic problem solving for physics learning. This study tested the feasibility of this method in physics learning using the one-shot case study experimental research method. The research was conducted at SMAN 8 Makassar. The feasibility of the DPS strategy was assessed by four observers, resulting in an average implementation score of 83.19%. Based on these results, the DPS strategy can successfully engage students in physics learning by enhancing their problem-solving skills.

Keywords: dynamic problem-solving; higher-order thinking skills; strategy

Received : 5 December 2023

Accepted : 3 April 2024

Published: 26 June 2024

DOI : https://doi.org/10.20527/jipf.v8i2.11137

How to cite: Haris, A., Hasyim, M., Ramadhan, I., Aisyah, N., Fatmawati, F., & Wibawa, T. (2024). Development of dynamic problem-solving teaching method in high school physics learning. *Jurnal Ilmiah Pendidikan Fisika*, *8*(2), 168-173.

INTRODUCTION

Education serves as the primary foundation for shaping thinking processes and developing intelligence and a means to transmit values and ideas and enhance thinking abilities (Funke & Greiff, 2017; Darmaji et al., 2019). Currently, the ability to compete for a decent life depends heavily on creativity and innovative skills (Bao & Koenig, 2019). Law No. 20 of 2003, Article 3, states that the goal of national education is to develop the potential of learners so that they become skilled, creative, and knowledgeable individuals. Continuous efforts are made to improve the quality of education (Funke et al., 2018), focusing on developing logical, systematic, and critical thinking skills in line with the demands of 21st-century learning (Wüstenberg et al., 2014; Yani et al., 2021). This improvement is particularly directed towards the development of High Order Thinking Skills (HOTS) in physics subjects (Brookhart, 2010; Dewantara et al., 2021).

HOTS are defined as a process where learners can apply complex and open-ended ideas, involving elaborate thinking (Reed & Vallacher, 2020; Resing et al., 2016). This can strengthen learners' abilities in critical, creative, and reflective thinking (Ansari & Abdullah, 2020; Schulz, 2016; MOE, 2013). According to Boham & Dome (2021), HOTS refer to learners' ability to handle and process knowledge or ideas creatively and innovatively, accompanied by their own discovered relationships (Hodosyova et al., 2015). In developing HOTS, learners are expected to connect facts, classify them, manipulate them, place them in new contexts, and use these ideas to find solutions to their problems.

The Ministry of Education and Culture (2019) reported that a Programme for International Student Assessment (PISA) survey ranked Indonesia 64th out of 72 surveyed countries. This result was obtained from the 2018 National Examination questions, which included reasoning problems aligned with both Indonesian and international standards, such as the PISA standard.

Brookhart (2010) stated in his book that high-order thinking can be considered problem-solving. This assumption aims to equip learners to identify and solve problems within themselves, including solving new problems they define and creating new ideas as solutions.

To enhance learners' thinking abilities, educators must be creative in creating a learning environment that supports learning goals. Educators need learning strategies and should consider factors that facilitate learning. Ideal learning strategies to develop learners' HOTS focus on the learners themselves. According to Limbac & Waugh (2009), success in improving HOTS requires careful consideration of instructional techniques and a commitment to an active learner-focused environment. In their book, Knapp & Glenn (1996) also express a similar opinion that HOTS can only improve if learners are actively involved in generating new ideas and synthesizing information to broaden their understanding.

The development of learners' HOTS can be achieved by turning learners into problem solvers. An appropriate strategy to enhance learners' HOTS is to apply a dynamic problem-solving strategy in learning (Haris et al., 2016).

The results of previous research conducted by Haris indicate that the Dynamic Problem Solving (DPS) learning strategy can improve problem-solving abilities in complex physics, albeit with a considerable amount of time. Furthermore, in this study, there is also a positive response from the respondents, as evidenced by satisfactory test results (Nirmalakhandan, 2013; Stevenson et al., 2016). The research also demonstrates that the conceptual understanding abilities of the respondents are probably good (Haris et al., 2016). Meanwhile, in this study, the author focuses on examining the implications of the development of the DPS strategy on the HOTS of learners. Overcoming problems dynamically involves successfully interacting with a task environment that constantly changes, where some patterns within that learning environment can only be resolved through exploration and integration of the information obtained during the learning process. Dynamic problem-solving is well-suited for such a role because tasks that evaluate it require acquiring and applying knowledge (Csapó & Molnár, 2017).

Based on the above description, this research examines the effectiveness of the dynamic problem-solving-based learning strategy on learners' HOTS. This research aims for learners to become more creative and innovative in solving their problems. The DPS strategy is highly suitable for specific roles or situations because the tasks involved in its evaluation require students to acquire new knowledge and apply that knowledge effectively to solve problems. Particularly in physics, which studies natural phenomena requiring a high level of thinking to understand physics phenomena such as electric and magnetic fields, quantum phenomena, etc.

METHOD

This research is a pre-experimental study (Mertens, 2010). A pre-experimental study design only involves testing before or after treatment in a single group or class. This design aims to describe the feasibility of learning based on dynamic problem-solving (DPS) strategies using a learning implementation assessment instrument. This instrument measures several indicators, such as opening learning, which consists of preparing students physically and mentally, motivating students, delivering apperception, conveying learning objectives, and delivering material coverage. The second indicator is core activities, including mastery of material and implementing models/approaches/ strategies. The final indicator is closing learning, which consists of summarizing learning materials and conducting reflection and follow-up actions. The research was conducted in schools in Makassar, specifically at SMAN 8 Makassar as the research subject. Following Sugiyono's approach, this research utilized a one-shot case study design, which can be described as follows:

X O

X: Dynamic Problem-Solving Strategy-based Learning

O: Results of the implementation of Dynamic Problem Solving Strategy

The feasibility of DPS is assessed based on the use of teaching modules that align with the steps of DPS learning. The assessment of the feasibility of the learning strategy is obtained from the observation results of four observers who are physics education lecturers during the learning process. The score categories can be seen based on the established scoring criteria. The observation scores of the feasibility of the DPS learning strategy obtained are entered into the feasibility calculation formula as follows:

$$\% \text{ Feasibility} = \frac{JSK}{JSM} \times 100\% \qquad \text{... (1)}$$

Explanation:

TFS = Total Feasibility Score

TMS = Total Maximum Score

The feasibility percentage obtained using the above formula is entered into the categorization, as seen in Table 1.

Table 1 Implementation strategy category

Score Interval (%)	Category
84 – 100	Excellent
67 – 83	Good
50 – 66	Fair
33 – 49	Poor
⩽ 32	Not Satisfactory

(Karmila, 2016)

RESULT AND DISCUSSION

The Dynamic Problem-Solving (DPS) learning strategy can transform students into problem solvers capable of addressing concrete issues in their daily lives. This strategy can foster critical and innovative thinking skills in solving problems, especially those related to abstract materials.

Using observation sheets tailored to the teaching module can accurately assess the success level of dynamic problem-solving learning. Four observers observed the teacher's modelling activities during the learning process.

Table 1 Average percentage score of learning activity implementation

No	Name	Teaching Activity			Score	Percentage
		Introduction	**Main**	**Closing**		
1	Observer 1	42	94	17	153	85.0%
2	Observer 2	49	97	18	164	91.1%
3	Observer 3	38	88	14	140	77.8%
4	Observer 4	40	89	13	142	78.9%
Overall Percentage Score				**83.19%**		

Based on Table 1, it is evident that the lowest scores are at the initial stage of learning. During this stage, the application of learning steps is less than optimal for delivering learning objectives and material coverage. The less conducive classroom conditions at the beginning of the learning activity hinder the implementation of the planned learning steps to their maximum potential (Hidayati & Ramli, 2018). The lowest scores are also observed in the concluding stage of the learning activity, specifically in the reflection and follow-up points. The lack of class time challenges teachers to guide students in reflecting and following up on activities to their fullest extent. Overall, the learning steps receive relatively stable scores in the core activities, which include stimulus, problem identification, data collection, proof, and concluding (Lopez-Jiménez et al., 2021). The average scores for the implementation of the learning strategy by four observers are presented in Figure 1.

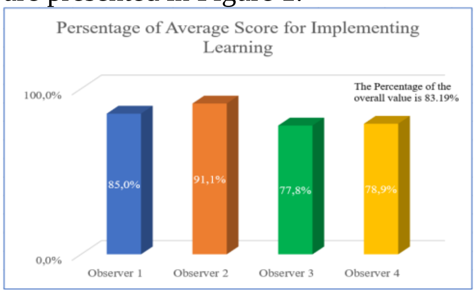

Figure 1 Average percentage score of learning activity implementation

The results of the observation categories based on Figure 1 fall into the "Well Implemented" category (Karmila, 2016). This category is achievable due to the implementation of learning steps that align with the learning syntax prepared by the teacher. As a result, the learning process is considered to be efficient. The dynamic problem-solving strategy consists of three stages: the initial stage, the core stage, and the concluding stage.

In the introduction stage, the teacher prepares students physically and mentally, motivates them, delivers apperception, communicates learning objectives, and presents material coverage (Haris, 2016). This stage consists of five parts: stimulus, problem identification, data collection, proof, and concluding, each with its respective assessment points. In this study, the teacher model was less than optimal in providing stimuli to the learners, resulting in a lack of attention from the learners towards the model teacher's explanations.

The concluding stage of the learning activity is carried out by inviting students to summarize the learning material and reflect on and follow up on the learning activities that have been conducted (Ince, 2018). The learning stages are implemented according to the planned learning activities, and the categorization of implementation based on Figure 1 indicates that the results are satisfactory (Greiff et al., 2012). This suggests that the dynamic problem-solving strategy can be used as an alternative strategy in teaching.

CONCLUSION

The implementation of learning using the dynamic problem-solving strategy obtained an average score percentage from Observer 1 of 85%, Observer 2 of 91.1%, Observer 3 of 77.8%, and Observer 4 of 78.9%, with an overall percentage score of 83.19%. This indicates that the stages of learning activities using the dynamic problem-solving strategy were well executed. The development of this DPS strategy has successfully enhanced the high-order thinking skills of learners, as indicated by the growth in problem-solving abilities of the students. The advancement in problem-solving skills is in line with the development of critical thinking skills and conceptual understanding among the learners.

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