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Remediation of Student Errors in Solving Work and Energy Problems Using the Fast Feedback Method

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Abstract. The study aims to determine the effectiveness of the fast feedback method based on problem-solving according to Polya in remediating student errors in solving work and energy problems at SMP Negeri 4 Dedai. This study is in the form of a pre-experimental study with a one-group pre-test post-test design. The sample of this study consisted of 22 students from class VIII B, which was the experimental class. The data collection tool was a 5-item essay test validated (validity level of 3.6 in the moderate category) and tested for reliability (reliability level of 0.489 in the moderate category). The study results showed an average percentage decrease in student errors in the experimental class of 90.2%. The effectiveness of remediation showed a proportion price of 0.886%. It is hoped that this study can be used as an alternative to student error remediation methods in solving problems on work and energy materials.

Keywords: remediation, fast feedback, Polya

1. Introduction

Education is an effort that is done consciously and planned to create a pleasant learning atmosphere. This aims to make students actively develop their potential [1]. The challenge in the world of education is how to produce human resources who can face various challenges in life. Quality human resources must have the ability to think critically, creatively, systematically, be able to solve problems, and also have good morals [2]. To produce quality human resources, the first step that needs to be taken is to improve the quality of education itself. One way that the government can improve the quality of education is by implementing an independent curriculum in schools. This curriculum has different characteristics, namely prioritizing more interactive and collaborative learning methods, so that students can be more active in the learning process and develop the skills needed for the future [3].

Natural Sciences (IPA) is a subject taught from elementary school to junior high school. It is a collection of systematic theories that develop through scientific methods such as observation and experimentation [4]. Science learning provides opportunities for students to gain direct experience in protecting and preserving the environment [5]. Physics, as part of science, which is studied at the secondary education level, focuses on natural phenomena and their measurement [6]. The aim of learning physics is for students to master knowledge and skills and be able to apply them in everyday life [7]. Understanding physics concepts is very important, because solving physics problems does not only depend on formulas, but also a correct understanding of physics concepts. However, many students still have difficulty understanding the concept of physics. This difficulty causes them to make mistakes in solving physics problems. Some types of errors that often occur are conceptual errors, data usage, strategies, systematics, calculations, and unresponsive questions [8].

Students' difficulties in solving physics problems can be analyzed using the Polya Model, which consists of four stages: understanding the problem, planning a solution, implementing the plan, and rechecking the results [9]. Previous research also shows that students often experience difficulties at these various stages, with the stages of understanding questions and checking answers being the most problematic [10]. To overcome this error, remediation action is needed. Remediation aims to help

students who have difficulty mastering competencies and solving problems correctly [11,12]. One method that can be used in remediation is feedback. With this method, teachers can provide direct feedback to students, so they can immediately correct the mistakes that occur [13]. The feedback method provides immediate feedback to students, allowing them to correct mistakes on the spot and improve their understanding. The use of feedback is effective in improving student learning outcomes and reducing physics and mathematical errors [14]. With fast and accurate feedback, students can better understand the material they have learned and correct their mistakes more efficiently [15].

In SMP Negeri 4 Dedai, there are still many students who have not met the Minimum Graduation Competency (KKM) on the material about work and energy. The results of interviews with teachers showed that many students had difficulty working on questions, especially in terms of understanding the questions, planning how to solve them, and rechecking the answers that had been given. Therefore, this study aims to overcome these errors by providing feedback based on problem solving according to Polya, so that it can help students correct their mistakes and improve their understanding of the material on work and energy.

This study has several limitations, namely, first, some students do not finish working on the questions, so the data obtained is difficult to analyze because the errors made are not necessarily valid. Second, the implementation of the fast feedback method is not yet fully optimal, because there are still obstacles from researchers, such as a lack of experience in effective implementation, limitations in time management and feedback strategies, and a lack of adjustment to student conditions.

Furthermore, this research is also expected to provide benefits for various parties. For students, this research can increase motivation, enthusiasm, and creativity during learning and remediation, expand knowledge about work and energy materials, and improve the ability to solve problems at the right stages. For teachers, this research is useful for identifying student errors in solving physics problems on work and energy materials and as input for designing learning improvement programs in the future. For schools, this research can help overcome student difficulties in work and energy materials and be a reference for the application of appropriate learning methods in teaching and learning activities, especially in science learning. For physics education study programs, this research can be used as a reference for further research or other needs related to the development of study programs.

2. Method

The form of research used is a pre-experiment with a Group Pre-test Post-test Design. One Group Pre-test Post-test Design is an experimental research design involving one group of students. In this design, measurements are made on the variables to be studied before the experiment begins (pre-test), then treatment is given to the group. After that, the same variables are measured again (post-test) to see the changes that occur due to the treatment.

This research was conducted at SMP Negeri 4 Dedai involving 70 students who had studied the material about work and energy. The students were divided into three classes, namely class VIII A, VIII B, and VIII C. In this study, the sampling technique used was an intact group with random sampling, and the selected sample was class VIII B, consisting of 22 students.

The data collection technique applied in this study is a measurement technique, which involves collecting data through tests given before and after treatment. The instrument used is in the form of descriptive questions about work and energy material, consisting of 5 questions. The level of validity of the pre-test and post-test questions each has a value of 3.6, which is included in the moderate category. The reliability of the error measurement instrument for the pre-test and post-test, with a moderate interpretation, is 0.489.

To analyze the data, this study identified the types of errors made by students in the pre-test and post-test based on problem-solving according to Polya, which consisted of errors in understanding, errors in making plans, errors in implementing plans, errors in re-checking the solutions obtained [16], and then calculate the average percentage reduction in student errors using the equation (1).

$$\Delta K = \frac{K_1 - K_2}{K_1} \times 100\% \quad (1)$$

where ΔK Is the decrease in error (%), K_1Is the number of errors in the pre-test, and K_2 Is the number of errors in the post-test.

The effectiveness of remediation for each question indicator is calculated by the proportional price of the decrease in the number of errors in the pre-test and post-test results using the equation (2).

$$\Delta S = \frac{S_0 - S_1}{S_0} \quad (2)$$

where ΔS is the proportional value of the decrease in the number of errors for each question indicator, S_0 Is the number of errors for each question indicator in the pre-test, and S_1 Is the number of errors for each question indicator in the post-test.

3. Results and Discussion

This study aims to determine whether the feedback method based on problem solving according to Polya is effective or not in remediating student errors in solving work and energy problems at SMP Negeri 4 Dedai. The results of the analysis related to the number of errors made by students in solving pre-test and post-test problems can be seen in Table 1.

Table 1. Student error profile. Information: KMM is Misunderstanding the Problem, KMP is Planning Errors in Solving, KMRP is Error in Executing the Solution Plan, KMKP is Error Rechecking Solution.

No.	KMM				KMP		KMRP						KMKP			
	The error of determining what is known		Error determining what is being asked		Error writing solution steps		Error completing completion step		Mathematical calculation error		Error in determining units		Mathematical calculation error		Error writing final answer	
	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test
1.	13	3	14	0	9	3	7	3	7	0	15	0	7	3	22	0
2.	22	5	14	0	9	5	9	5	9	5	14	5	9	5	22	0
3.	5	0	5	0	5	0	5	0	5	0	5	0	5	0	22	0
4.	17	0	17	0	20	0	22	0	22	0	22	0	22	0	22	0
5.	27	0	22	0	22	0	22	4	22	4	22	4	22	4	22	0
	Amount Pre-test = 156				Amount Pre-test = 65				Amount Pre-test = 208						Amount Pre-test = 175	
	Amount Post-test = 8				Amount Post-test = 8				Amount Post-test = 30						Amount Post-test = 12	

Based on the student error profile table, it can be seen that the types of problem-solving errors used are the steps of problem-solving according to Polya, which consist of errors in understanding the problem, errors in planning the solution, errors in implementing the solution plan, and errors in re-checking the solution. The four steps of problem solving according to Polya that were studied were made into several types of errors, so that the problem-solving carried out by students can be known more specifically and in detail, so that accurate data is obtained about the description of the types of problem-solving errors in students. In errors in understanding the problem, there are two indicators, namely errors in determining information that is already known and errors in determining what is asked in the question. Meanwhile, in errors in planning the solution, there is one indicator, namely errors in writing the solution steps. Errors in implementing the solution plan have three indicators, namely errors in completing the solution steps, mathematical calculation errors, and errors in determining units. And errors in re-checking the solution have two indicators, namely, mathematical calculation errors and errors in writing the final answer.

After analyzing the forms of student errors based on the results of five pre-test and post-test questions, the number of errors in understanding the problem in the pre-test was 156, and in the post-test was 8. The number of errors in planning solutions in the pre-test was 65, and in the post-test was 8. Furthermore, the number of errors in implementing the solution plan in the pre-test was 208, and in the post-test was 30. And finally, the number of errors in re-checking the solution in the pre-test was 175, and in the post-test was 12.

From the results of the analysis of the forms of errors made by students, the decrease in the number of errors in solving work and energy problems after being given remediation using the fast feedback method based on problem-solving according to Polya can be seen in Table 2.

Table 2. Error reduction for each type of error for the experimental class. Information: K_1-Number of errors during the pre-test, K_2-Number of errors during the post-test, ΔK-Error reduction (%).

No.	Error Type	Pre-test K_1	Post-test K_2	Error Reduction ΔK (%)
1	Misunderstanding the Problem (KMM)	156	8	94.8
2	Planning Errors in Solving (KMP)	65	8	87.6
3	Error in Executing the Solution Plan (KMRP)	208	30	85.5
4	Error Rechecking Solution (KMKP)	175	12	93.1
Average percentage reduction in errors				90.2

The decrease in each problem-solving indicator according to Polya shows that. K_1 and K_2 Are obtained from the number of errors during the pre-test and post-test, where the largest decrease is the error in understanding the problem (94.8%), this is because students only need to read and understand the information in the question, which is usually easier because it only involves understanding concepts and identifying basic facts. The lowest decrease is the error in implementing the solution plan of 85.5%, which is because students must apply the planned strategy or solution, which involves technical steps, calculations, or the application of more complex concepts. This stage is more difficult because it requires practical skills, accuracy, and deep understanding to be able to solve the problem correctly. So that the average percentage of error reduction for each type of error is 90.2%.

Furthermore, this study also found the effectiveness of using the feedback method according to Polya in remediating student errors in solving work and energy problems. Effectiveness was calculated by comparing the decrease in errors between the pre-test and post-test in the experimental class. As a result, the proportion obtained in the experimental class was 0.886, which indicates a high level of effectiveness.

This finding is in line with previous research, which states that feedback can improve the ability to recognize correct answers, identify errors, improve performance, and strengthen the memory of knowledge that has been learned [17]. In addition, direct feedback also helps reduce the possibility of students repeating mistakes on subsequent tests. In addition, remediation using the feedback method is also effective in reducing the number of students who experience misconceptions about Archimedes' law material, with a relatively high effectiveness (d 1.87) [18]. The success of the feedback method was also found in previous research, which stated that the feedback method had a significant effect on reducing the number of student errors in solving problems [14,19,20].

Thus, it can be concluded that the feedback method based on Polya's solution can remediate students' errors in solving work and energy problems at SMP Negeri 4 Dedai. This conclusion is by previous research, which states that the application of Polya's strategy in science learning can improve students' problem-solving abilities, which increased from cycle I, cycle II, to cycle III. In cycle I, only 45% were completed, cycle II was 80%, and cycle III reached 100%, or all students had met the minimum completion criteria [21]. The success of problem-solving, according to Polya, was also found in previous research, which stated that the application of the Polya model can improve students' ability to solve story problems about comparison and scale. The average problem-solving ability increased from 55.93% in the pre-cycle to 84.38% in cycle II [22].

4. Conclusion

From the results and discussions, it can be concluded that the fast feedback method based on problem solving according to Polya can remediate students' errors in solving work and energy problems in class VIII of SMP Negeri 4 Dedai. The large decrease in the number of student errors in solving work and energy problems after being given remediation with the fast feedback method based on problem-solving, according to Polya, shows an average percentage of 90.2%. This decrease includes (94.8%) for errors

in understanding the problem, (87.6%) for errors in planning the solution, (85.5%) for errors in implementing the solution plan, and (93.1%) for errors in rechecking the solution. The effectiveness of using the fast feedback method based on problem solving, according to Polya, to remediate student errors in solving work and energy problems in class VIII of SMP Negeri 4 Dedai is at a high level with a proportion price of 0.886.

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