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[Research Article]

THE INFLUENCE OF STUDENTS SELF-EFFICACY ON CLASSIC MECHANICS PROBLEM SOLVING ABILITY WITH THE POLYA MODEL

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ABSTRACT

The concepts of Classical Mechanics mostly employ mathematics in their approach to the material, thus involving calculations with derivative and integral formulas. In order to make the problems presented in Classical Mechanics relatively easy to solve, a structured problem-solving procedure is needed. One such procedure that can be implemented is the Polya problem solving model. In addition, students' self-efficacy in solving Classical Mechanics problems influence their level of success. The results of a survey on students of The Tadris Physics Department at UIN Syarif Hidayatullah Jakarta showed that there is a high and low influence of students' self-efficacy on the problem solving abilities of Classical Mechanics in students with the Polya model significantly (U = 50.500 and p-value = -5.788/2 = -2.894, this score is less than 0.05 (-2.894 < 0 .05) and Asymp.Sig = 0.000 < 0.05).

Keywords: *Self Efficacy, Problem Solving Ability, Polya Model, Classical Mechanics*

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1. INTRODUCTION

Physics is known as an exact science which has its own level of difficulty in studying it. Most of students relatively often face difficulties in solving physics problems which are mostly mathematical in nature. This is what causes many assumptions from physics students to be considered non-contextual, even though physics concepts are related to natural phenomena that are widely found in students' daily lives.

The fact that physics is still considered a difficult subject cannot be avoided by physics teachers/lectures. Therefore, in presenting physics problems, it should be equipped with a procedure for solving problems that can make it easier for students to understand the teaching material presented in learning activities. This is an exception in Classical Mechanical lectures.
The problem according to Vessen (in Ratna, W.D., 2011) is the dissimilarity between two or more statements delivered to students during the teaching and learning process. The ability to solve a problem is basically the main goal of the educational process. Problem solving is an activity that involves establishing high-level rules.

Problem solving is an activity that not only requires information from the subject area but also uses the right method. Problem solving, interest, wanting to know, and curiosity are the basic elements that facilitate learning.

Dahar (2011) argues that, "Problem solving is human activity that combines previously acquired concepts and rules, and not as a generic skill." Based on Dahar's opinion, the ability to solve one's problems must be based on the ability of the concept the problem wants to solve and certain rules so that the problem solving process is structured.

Problem solving procedures have been widely proposed by experts. One of them which is very well known in learning that contains many mathematical formulations, such as physics concepts in the Polya solving model.

Polya a mathematician, introduced a four-step problem solving in his book entitled "How to Solve It" in 1985. The four steps are follows.

1) Understanding the Problem

   At this stage, students can describe in full what is known and what is asked in the problem. The stages of understanding this problem solving include: recognizing questions, analyzing questions, and translating known information including making pictures or diagrams to help students imagine the conditions.

2) Make a Plan

   At this stage, students must be able to think about what steps are important and support each other to be able to solve the problem. In other words, at this stage students can look for concepts or theories that support or determine formulas or theorems related to the problem.

3) Execute the Plan

   At this stage, students are ready to perform calculations with all kinds of data needed including the appropriate concepts and formulas or equations. Students are required at this stage to be able to form more standard systematics in the sense that the formulas used are formulas that are ready to be used according to what is asked in the problem, then enter data so that it leads to a solution plan. After that, just carry out the plan so that what is expected can be proven.

4) Revisiting

   At this stage, students re-check the solution to the problems they have done to ensure that the answers obtained are reasonable or rational. Students are expected to have skills in solving problems at this stage. Students can reflect/re-check and review carefully every step taken.

The Classical Mechanics course is known as one of the most mathematical subjects because most of the concepts in Classical Mechanics are

studied from the point of view of mathematical formulations. If students want to master the lecture material in Classical Mechanics, they are required to have quite high mathematical abilities because there are many formulas related to derivatives and integrals. Therefore, in solving problems in Classical Mechanics, it is necessary to assist with structured problem solving procedures. The application of the Polya problem-solving model is relatively relevant because it is characteristically compatible, that is, both are mathematical problems.

Another thing that is considered to influence students' ability to solve problems in Classical Mechanics, apart from understanding the procedure for solving problems is the psychological aspect – self-efficacy. The term self-efficacy is often interchanged with self-confidence, even though the two have different meanings (Alasaad & Said, 2021), (Rakoczy et al., 2019). Self-efficacy refers to the belief that a person has in his ability to achieve something that is needed, while self-confidence refers to a person's belief in himself that is generally not specific to something (Nieminen et al., 2021), (Putranta et al., 2021).

Self-efficacy became popular in the 1980-1990. One of the famous experts who popularized the term self-efficacy is Albert Bandura (1997) in his book entitled "Self-efficacy: The Exercise of Control". Bandura himself is the founder of the concept of Observational Learning. Bandura explicitly states that self-efficacy is a person's belief in his ability to organize and carry out a series of actions needed to complete a particular task (Faridi et al., 2021), (Ma et al., 2021).

Other experts, such as Alwisol (2012) define self-efficacy as one's own perception of how oneself can function in certain situations. Based on Alwisol's statement, it can be understood that self-efficacy is related to self-confidence in having the ability to perform the expected actions.

Self-efficacy has dimensions. Bandura (1997) divides the dimensions of self-efficacy into 3 types, namely level: magnitude, strength, and generality.

1) *Magnitude*

   The magnitude dimension relates to the difficulty level of the task. The magnitude of self-efficacy will affect the selection of activities, the amount of the effort, and a person's resilience in facing and completing the task he undertakes. Judging from the magnitude dimension, people who have high self-efficacy tend to easily complete all tasks given to them, no matter how difficult the task is. Conversely, people who have low self-efficacy in the magnitude dimension tend to find it difficult to complete all the tasks assigned to them even though the task difficulty level may not be high.

2) *Strength*

   The strength dimension relates to the level of a person's ability to believe in the resilience he has. Judging from the strength dimension, people who have high self-efficacy tend to survive in any situation. Here we can see that the person seems persistent and diligent in trying to achieve the target that has been set. Conversely, people who have low self-efficacy in the strength dimension will tend to give up easily even though the difficulties they face in carrying out their tasks may not be much.

3) *Generality*

   The generality dimension of the field of behavior relates to the level of one's ability to belief that one's self-efficacy is not limited to certain circumstances. This measure refers to the different conditions under which self-efficacy evaluations can be determined. This generality is related to one's belief in the ability to complete task in various activities. Various activities require a person to believe in the ability to complete the task.

The extent to which students' self-efficacy influences their problem-solving skills in Classical Mechanics is described in this study. The students who took the Classical Mechanics lecture were given test with problem solving

procedures using the Polya model. Then measured the level of self-efficacy.

2. METHOD

The research method used was a quasi-experimental method conducted on Physics Education students at UIN Syarif Hidayatullah for the 2022/2023 academic year. The instrument used was a problem solving ability test with the Polya model and questionnaire with scale based on Schwarzer, et al. (2002) with a range of 1-4 and a total of 12 items. The data analysis technique uses the Mann-Whitney test.

2.1 The hypothesis

H_0 = There is no significant difference in the problem-solving abilities of Classical Mechanics in students with the Polya model in terms of their high and low self-efficacy.

H_1 = There is a significant difference in the problem-solving abilities of Classical Mechanics in students with the Polya model in terms of their high and low self-efficacy.

Test criteria: Hypothesis H0 is rejected if $H_0 > X^2_{tabel(\propto,k-1)}$ or hypothesis H_0 is rejected if Asymp. Sig < 0,05 using SPSS 26 calculation.

3. RESULT AND DISSCUSSION

3.1 Grouping Levels of Self-Efficacy

The sample in this study consisted of 58 students who took classes in Classical Mechanics. Students are given a test with the Polya model problem solving procedure, then given a self-efficacy questionnaire and the following results are obtained.

Tabel 1. Students' Self-Efficacy Level

Group	Self-Efficacy Level	N
A	Tinggi	31
B	Rendah	27
N Total		58

3.2 Results of Data Analysis with SPSS 26

Descriptively (Table 2) the SD results for problem solving abilities are 12.562. This shows that the average distribution of the students' problem solving abilities in Classical Mechanics using the Polya model is quite large. This means that the distribution of the sample data is large relative to the average value (65.28).

Tabel 2. Deskriptive Statistics

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
Kemampuan Pemecahan Masalah	58	65.28	12.521	40	87
Efikasi Diri	58	1.47	.503	1	2

In terms of the mean rank (Table 3), the average rating of the problem solving abilities of students who have a high level of self-efficacy is greater than the average problem solving ability of students who have a low level of self-efficacy, that is 41.37 < 15.87. Based on the average rating, it shows that the problem solving abilities of students who have a high level of self-efficacy are far greater than those of students who have a low level of self-efficacy.

Tabel 3. Mean Ranks

Ranks

	Efikasi Diri	N	Mean Rank	Sum of Ranks
Kemampuan Pemecahan Masalah	Tinggi	31	41.37	1282.50
	Rendah	27	15.87	428.50
	Total	58		

The results of the Mann-Whitney test (Table 4) show that the price is U = 50.500 and the p-value = -5.788/2 = -2.894 where this score is less than 0.05 (-2.894 < 0.05). Then obtained Asymp.Sig = 0.000 < 0.05, so this shows that the hypothesis H_0 is rejected. Thus, the H1 hypothesis is accepted, meaning that there is indeed a significant difference in the problem-solving abilities of Classical Mechanics in students with the Polya model in terms of high and low self-efficacy.

Tabel 4. Mann-Whitney U Test Results

Test Statistics[a]

	Kemampuan Pemecahan Masalah
Mann-Whitney U	50.500
Wilcoxon W	428.500
Z	-5.788
Asymp. Sig. (2-tailed)	.000

a. Grouping Variable: Efikasi Diri

The results of this study indicate that indeed self-efficacy has an influence on student academic achievement. The results of this study are in line with the results of other studies on self-efficacy, such as those conducted by Dzulfikar, A., (2019); Nuraeni, S., Feronika, T., & Yunita, L., (2019); Rakoczy, K., Pinger, P., Hochweber, J., Klieme, E., Schütze, B., & Besser, M., (2019); Dixon, H., Hawe, E., & Hamilton, R., (2020); Kelley, T. R., Knowles, J. G., Holland, J. D., & Han, J., (2020); Pujaningsih, P., & Ambarwati, U., 2020 ; Polizzi, S. J., Zhu, Y., Reid, J. W., Ofem, B., Salisbury, S., Beeth, M., & Rushton, G. T., (2021); Myyry, L., Karaharju-Suvanto, T., Virtala, A. M. K., R Raekallio, M., Salminen, O., Vesalainen, M., & Nevgi, A., 2022; Semilarski, H., Soobard, R., Holbrook, J., & Rannikmäe, M., (2022); Yang, et al., (2021), dan Yuwentin et al., (2020).

The results of research by Dzulfikar, A. (2019) succeeded in showing that if Mathematics teaching materials are designed based on self-efficacy, it will help relieve students' anxiety when facing Mathematics tests thereby helping students obtain higher test results. Based on the results of the research conducted in the Classical Mechanics lecture, it is also illustrated that students' self-efficacy has a significant effect on their ability to solve test problems in Classical Mechanics.

At the stage of understanding the problem, most students have high self-efficacy that they always understand the context of the problem given in the test (95%). All students stated that they always wrote down the quantities that were known and asked in the test at the stage of undertansing the problem.

At the problem-solving planning stage, most students have high confidence that they often make problem-solving plans in test problems based on the theory/laws/principles of physics (78%). A few others said they rarely do because they are used to using quick ways to solve problems in test questions (10%) and some others stated that they always plan to solve problems in test based on the theory/laws/principles of physics (8%).

At the stage of implementing problem solving planning, as many as 53% of students have high self-efficacy in solving physics problems and always think correctly because they have examined the relevance of the basic theory/laws/principles to the context of the physics problem presented in the previous problem. Meanwhile, 38% of students often have confidence in solving physics problems and only 8% feel they don't have self-efficacy in thinking correctly in solving problems in the test given.

At the stage of looking back at the completeness of problem solving, most students rarely do it (65%). This is assumed because at the stage of showing the problem most of them already feel confident with the answers that have been given.

4. CONCLUSION

Based on the results of the data analysis that has been done, it can be concluded that there is a significant high and low influence of students' self-efficacy on the problem solving abilities of Classical Mechanics in students with the Polya Model.

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