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Problem Solving Prospective Physics Teachers on Free Falling Materials

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1. Abstract

Learning physics is required not only to be able to master basic concepts but also to apply them in solving problems. Physics learning to datehas not emphasized problem solving procedurally so that students still tend to use the plug and chug approach (not clear approach) and memory-based (recalling similar problems) in solving physics problems. purpose pre-search form for analyzing the problem-solving abilities of physics teacher candidates on free fall motion material using magic card science media. StudyThis is a quantitative descriptive researchinvolving prospective physics teachers at a private university in Yogyakarta, totaling 37 prospective physics teachers who had attended basic physics courses. Problem solving questions in the form of open descriptions amount to 2 description questions. The results of the study in general, the average problem-solving ability of prospective physics teachers is in the medium category, which tends to be dominated by the high category. Another findat the problem solving stage *specific application of physics* and the average mathematical procedure category is high. This shows the need for creative, innovative and communicative physics to support the problem-solving abilities of prospective physics teachers more optimally.

Keywords: problem-solving, physics, free falling, category

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2. Introduction

In learning to develop students' knowledge, understanding, and analytical skills of the surrounding environment (Azizah et.al, 2017). Physics learning is required not only to be able to master basic concepts but also to apply them in solving problems (Sutopo, 2016).Physics learning currently does not emphasize procedural problem solving so that students still tend to use the plug and chug and memory-based approach in solving physics problems (Walsh at al., 2007; Brad, 2011; Erceg, 2011). In developing and compiling knowledge that is useful for solving various problems (Dahar, 2011; Selcuk, 2008) and using the information and skills obtained to solve problems Slavins, 1986). However, what often happens is that learning in the classroom tends to emphasize mastery of concepts and overrides students' physics problem-solving abilities (Hoellwarth, 2005). There are three research focuses including identifying misconceptions that occur in students, developing and evaluating learning to overcome misconceptions and explaining the structure of knowledge in students' memory (Docktor et. al., 2015). Based on the three research focuses, research on conceptual understanding that still dominates and is widely researched (Sutopo, 2016). Many studies reveal conceptual understanding and misconceptions in the field of mechanics. One of the most basic mechanics concepts is rectilinear motion (Serway & Jewett, 2004). The concepts of force and motion, including acceleration, are basic concepts taught since high school (Docktor et. al., 2015; Young and Freedman, 2002; Sutopo et.al., 2011; Sutopo, 2012).

Previous research shows that most of the conceptual understanding is lacking in the field of mechanics even though they have learned these concepts before (Sutopo, 2011). The concept of rectilinear motion has many applications in the real world, however, many

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students experience misconceptions about velocity, speed, and acceleration (Hake, 1998; Reif & Allen, 1992; Ivowi, 1984; Aron, 2006; Shaffer & McDermott, 2005; Singh & Schunn, 2009; Brad, (2011). Students' quantitative problems tend to solve them in a plug-and-chug manner (Quminaro & Redish, 2007; Maloney, 1994), namely selecting the formula that is deemed suitable for the quantities mentioned in the problem without considering the physics ideas contained in the formula and the context in which the formula can be applied. Students tend to get stuck (don't have ideas) when faced with problems that involve many concepts, or problems that are context rich and unstructured (ill-structured) (Ogilvie, 2009).

According to the misconception theory, students' naive theories are stored in the form of a knowledge structure (cognitive schema) that is rigid (difficult to change its form), stable (not easily changed due to changes in context), coherent (not contradictory between substructures), and has a definite truth value (in terms of misconception is definitely wrong) (Dockor & Mestre, 2014). According to this view, misconceptions have been firmly embedded in students' memory because they were constructed over a long time and proved (for students) to be able to explain many phenomena; consequently misconceptions are very difficult to correct (Hassard & Dias, 2013; Scherr, 2007). Given that it tends to interfere with the construction of new knowledge (Dockor & Mestre, 2014), misconceptions must be removed from students' memory and replaced with new thoughts that are more scientific and coherent.

In the plane of straight motion, students also experience the wrong concept of acceleration due to gravity in the phenomenon of free fall. Most students in the class spontaneously say that an object with a greater mass will fall faster than a lighter object

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(Suparno, 2013). Students assume that free fall is motion that falls freely. But after getting the learning the students add information that free fall is a motion that is only influenced by the earth's gravitational force (Young and Freedman, 2002; Serway & Jewett, 2004). Other findings on the free fall motion sub-topic are in accordance with Aristotle's opinion (Serway & Jewett, 2004), namely the heavier an object, the faster the object falls compared to a lighter object. Even though the two objects will fall with the same acceleration and the same time (if there are no other elements that affect it) (Suparno, 2013). Based on this description, it is observed that research related to conceptual understanding and problem solving is still classified as important to do.

In physics learning, the ability to solve students' problems is still relatively low. In working on physics problems given by the teacher, students more often use mathematical equations without doing analysis, guessing the formulas used and memorizing examples of problems that have been done to work on other problems. Students still often use plug and chug and memory based approaches in solving physics problems (Walsh at al., 2007; Brad, 2011). There are several factors that affect the weak ability of students' problem solving. According to Ogunleye, students cannot solve problems including not enough practicum in the laboratory, confusion in writing unit conversions, lack of physics books to use as references (Ogunleye, 2009). Lack of problem solving skills includes a weak understanding of the principles and rules of physics,

The development of 21st century learning has increased very rapidly. The development of learning in particular emphasizes students' thinking skills, including social skills, self-management skills, problem-solving abilities, and thinking skills (National Research Council, 2012). Based on these skills, it is important to focus on solving non-

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routine problems (National Research Council, 2012). In solving problems, students are required to find concepts or principles that are appropriate to the problem, then use their knowledge to solve the problem (Docktor et. al., 2015). Learning strategies for solving problems can be assisted through group collaboration (Docktor et. al., 2015). Many students already have a good understanding of concepts and principles, but still lack the ability to solve physics problems (Cruz & Lapinid, 2014).

In the discussion of free fall about an object released from a height of h meters above the ground without initial velocity. Then to find the speed of the object at the time t the solution that is widely used is through a review of the acceleration due to gravity using the formula (Mosey & Lumi, 2016). In physics problems regarding free fall motion, students must be able to understand the concept of problem solving, not emphasizing memorizing formulas but can be done through unit review.

Students' problem solving abilities can be seen through the stages in problem solving. The stages in solving the problem begin with a useful description, physics approach, specific application of physics, mathematical procedure and logical progression Table 1 (Docktor et. al., 2015.

Useful Description

The term "useful" means that the description is used in the solution by a particular problem solver. The term "description" was chosen to be consistent with the use of other terms and to avoid multiple interpretations of the term "representation". This category is similar to the "Understand the problem" or "Represent the problem" stages in some problem-solving frameworks.

Physics Approaches

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Assess the solver's process in selecting the appropriate physics concepts and principles to use in solving the problem. Here, the term "concept" is used to mean general ideas of physics, such as vectors, or specific ideas such as momentum and velocity. The term "principle" is used to mean the basic physical rules used to describe objects and their interactions, such as the conservation of energy or Newton's second law. This category also includes an understanding of selected concepts, such as the independence of the perpendicular components of a vector.

Specific Application of Physics

Assessing the solver's process in applying the concepts and principles of physics to certain conditions in a problem. Specific applications often involve relating objects, quantities, and constraints in a problem using certain physical relationships. It can include definition statements, qualitative relationships between quantities, equations, initial conditions, and consideration of assumptions or constraints in the problem.

Mathematical Procedures

Assessing the process the solver chooses the right mathematical procedure and follows the mathematical rules to get the target amount. Examples of these procedures include algebraic strategies for isolating quantities or for simplifying expressions, substitution, integration operations, or "guess and check" for differential equations.

Logical Progressions

Assess the solver's process of staying focused on the goal while demonstrating internal consistency

Free fall is the motion of falling objects in a vertical direction from a certain height without initial velocity (Anderson, 1980). An object will fall to the ground if released from

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a certain height. The fall of the object is due to the acceleration of gravity (Mosey & Lumi, 2016). The event of the fall of an apple hitting Newton's head is an event of Free Fall. Free Fall (GJB) is a motion that falls from a height without an initial zero velocity, so it is only influenced by the acceleration of gravity. In one-dimensional motion (straight motion) the direction of velocity is represented/denoted by the +- sign. Sign + if in the direction of the + axis and sign - if in the opposite direction to the + axis (Young and Freedman, 2002; Serway & Jewett, 2004).

3. Methods

This research is quantitative descriptive (Giancoli, 2009). It is to know the ability level of problem solving skills of prospective teachers. The research involved prospective teacherslevel 1.2 Ta. 2021/2022 in Yogyakarta.The total sample of all prospective teachers consisted of 37 prospective physics teachers. The instrument used was in the form of essay test questions on the subject of Free Falling Movement as many as 2 items which were adopted from the questions in the UM Malang Physics Education Doctoral Program Assessment subject.

The stages of problem solving measured in this study consist of 5 indicators, including the stages in problem solving starting with a useful description, physics approach, specific application of physics, mathematical procedure and logical progression (Docktor et. al., 2015). The results are scored with a problem solving assessment rubric (Docktor et. al., 2015). The data obtained in this study is problem solving data through essay test techniques using the Google form link.

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From the results of this analysis it can be classified as problem solving for prospective teachers on free fall motion material in the low category X M-1*SD, while M-1*SD<≤*XM+*≤1*SD and high*XM+*>1*SD (Cresswell, 2007; Arikunto, 2012).

4. Results and Discussion

Research on solving problems for prospective physics teachers with analytical representations on Free Fall motion (GJB) material using Essay questions and one of the examples in Figure 1 which shows each category (low, medium and high). As for the media*magic science* GJB uses a stack of cards (1 set) experiment that is dropped freely from a certain height as shown in Figure 1.

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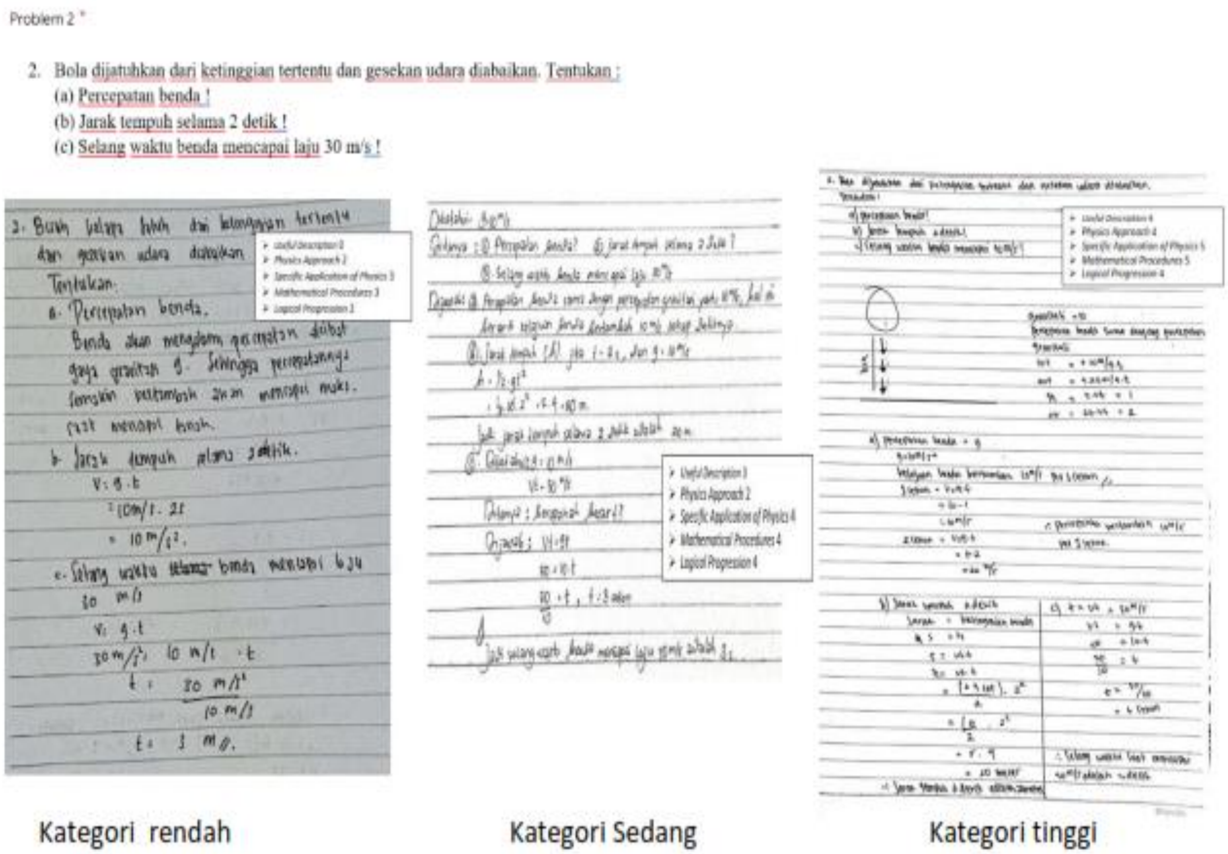

Figure 1. Examples of problem solving essay questions for prospective physics teachers in each category

Data on the results of measuring the problem-solving abilities of prospective physics teachers are shown in Table 1.

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Table 1. The results of measuring the ability of each stage of problem solving for prospective physics teachers

Problem Solving Stages	Frequency	Question Items	Category			Score	Category
			Low (%)	Currently (%)	Tall (%)	Average	Average
useful description	37	1,2	5	84	11	2.43	Currently
physicsapproach	37	1,2	0	54	46	3.23	Currently
specific application of physics	37	1,2	0	0	100	3.85	Tall
mathematical procedure	37	1,2	0	0	100	4.00	Tall
logical progression	37	1,2	0	65	35	2.72	Currently
Average			1	40.6	58.4	3.25	Currently

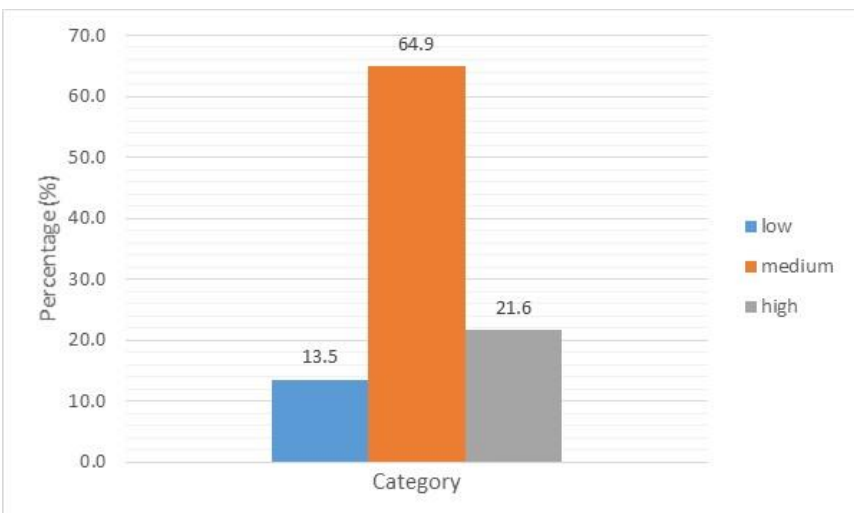

Figure 2. Percentage of problem solving abilities of prospective physics teachers

In table 1, it shows that the ability of each stage of problem solving for physics teacher candidates has an average score that varies, namely 4 stages fall into the medium

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average category and 2 other stages, namely*specific application of physics*and mathematical proceduresfall into the high average category. At these two stages it also shows that the ability of the problem solving stages of prospective physics teachers does not have low and medium category ratings. It means thatthe prospective teacher has taken part in physics lessons on free fall motion material with problem solving that uses analytical representations with magic science experimental media and does not apply a plug chug. Based on table 2, it is observed that the problem-solving ability of prospective physics teachers on average with a score of 3.25 is in the medium category. PThe percentage of solving free-fall motion problems for prospective physics teachers obtained an average rating in the low category of 13.5%, medium 64.9% and high category 21.6% (Figure 2).

5. Conclusion

The ability to solve problems for prospective physics teachers on free fall motion material by applying analytical representations obtains an average rating in the medium category. At stages*specific application of physics*and mathematical proceduresobtain an average ratinghigh category. The response of prospective physics teachers to the application of GJB problem solving with analytical representation strongly agrees.

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