

EVALUATION INSTRUMENTS TO DESCRIBE ABILITY OF THE PHYSICS PROBLEM SOLVING

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ABSTRACT:

This research aims to develop an evaluation instrument to describe the physics problem solving ability. In developing the instrument of problem solving ability, researchers adopt the instrument developed by Lynn that include 5 indicators, namely: useful description, physics approach, specific application of physics, mathematical procedures, and logical progression. The method used in this research is method development (R & D) by using a qualitative approach. Selection of this method to develop an evaluation instrument problem solving ability of students, implementation, and data collection. The subjects of this research is a student of physics education consisted of students with high academic ability as much as 2 people and students with low academic ability, as much as 2 people. The results showed that the evaluation instrument was developed to describe the problem solving ability of students are categorized either high or low category.

Keywords: evaluation instrument, physics problem solving.

INTRODUCTION:

Physics is one of the courses that underlie the development of technology, so that some study programs at the faculty of mathematics and natural science are required to programed this course in the form of Basic Physics course, which is given in the first year because this course is a requirement to

continue on the next course level. As the courses that are the basis for the next course, then a very important thing to understand is to instill the concept of basic physics. Herausgeber (2013) argued that "Physics Education Research in North America studies teaching and learning at the University level, with an emphasis on first year, because these are the courses that not only affect the largest numbers of students, but also constitute bottle necks for their future careers."

Campbell (2007) and Heller (1999) argued that the Basic Physics require complicated mathematics, material too much, depending on textbooks, abstract and complex, and requires laboratory activities. In line with this, Popov (2006) argued that "Physics is considered a difficult subject, demanding much effort from students. This effort is associated with memorising formulae for problem solving and working with a range of laboratory equipment."

Preliminary studies that have been conducted by researchers at the student who has programmed course Basic Physics was revealed that students had difficulty in solving the problem. Solving the problem is the efforts of individuals or groups to find answers based on the understanding that has been owned previously in order to meet the demands of an unusual situation (Krulik & Rudnick, 1996). Solving the problem is to find a way out of a difficulty, a way around an obstacle, achieve a certain goal is not immediately achievable or use various way out to solve a problem (Pólya, in Malone, 2006 and Heller, et al., in Kuo, 2004). The same thing was said by Mayer and

Wittrock (in Solaz- Portoles and sanjose, 2007) that problem solving is a process of cognition to achieve the goal when the method of solution is not obvious to the a discussant problem. For individuals or groups that get into trouble, of course, they want to solve the problem, and solving problems is something that people do every day (McGregor, 2007).

Problem solving is a thought that is directional directly to find a solution /way out a specific problem. Problem solving process has several steps. Starting from the evaluation of expectations, then make the hypothesis of solutions that may arise, to test the hypothesis, then confirm (Solso. 2008).

Lynn (2009) develop an instrument to measure the review problem solving skills with five indicators are: useful description, physics approach, specific application of physics, mathematical procedures, dan logical progression.

Based on the background that has been presented, the researchers developed an evaluation instrument to gain an overview physics student problem solving ability. Evaluation instrument is developed, referring to the instrument of problem solving the stated. (Lynn, 2009).

Problem of Research:

How does the evaluation instrument that can describe the physics problem solving ability?

Research Focus:

This research will focus on the evaluation instrument that can describe the physics problem solving ability.

METHOD:

General Background of Research:

The method used in this research is a method development (R & D) by using a qualitative approach. Selection of this method

to develop the problem solving ability students assessment, implementation, and data collection. So this method will support the implementation of the development of assessment instruments problem solving ability students in the course of Basic Physics.

Evaluation instruments developed will be implemented and analyzed using qualitative approach. A qualitative approach is a research paradigm to describe the events, behavior or a situation at a particular place in detail and depth in narrative form Satori (2009). According to Lincoln and Guba (1985) qualitative research conducted in natural settings or in the context of an entity.

Sample of Research:

Election of research subjects on the purpose (purposive sampling) (Prabowo, 2011: 49). Subjects were selected in this research are students which programmed the course of Basic Physics. The subjects in this research consisted of students with high academic ability and academic ability is low, amounting to 4 persons, consisting of 2 to subjects with high academic ability and 2 for subjects with low academic ability.

Instrument and Procedures:

This research will an evaluation instrument to describe the problem solving ability of students, evaluation instruments were developed adopting the instruments developed by Lynn and validated by experts in physics. While for the implementation of the instrument, its main instrument is a researcher with the use of tests and interviews. This is in accordance opinions Lincoln and Guba (1985) in a qualitative study that researchers as a data collection and interpretation of data obtained during the study.

Data Analysis:

The data were analyzed using a credibility test data that uses triangulation method, which compares the information or data with different methods (Lincoln and Guba, 1985). Testing is conducted by researchers credibility by verifying the data obtained in the form of documents written answers from the interview.

RESULTS AND DISCUSSIONS:

Results:

Based on the results of data validation by expert obtained that the evaluation instrument developed is valid with some suggestions and feedback for improvement. Suggestions and input of experts consisting of: a) the problem is solved should be clear; b) the determination of the assessment categories between categories of excellent, good, not good, and not good to be clearer; c) the problem needs to be stated in a sentence containing a subject matter that will be solved.

Based on the suggestions and input from experts, then researchers revise instrument problem solving ability, resulting in an instrument problem solving ability are valid and are equipped with a rubric that was adopted from the rubric developed by Lynn (2009).

Implementation of the evaluation instrument for problem solving ability test conducted on students assessment through tests and interviews. In this paper will only discuss two items assessment. For ease researcher in analyzing the data, the encoding used: (1) the category of high academic ability, the first subject is 1T, and the second is 2T; (2) categories of low academic ability first subject is 1R, and the second is 2R; and (3) the code P for researcher.

Problem solving ability subject will be disclosed by giving problems as contained in the instrument: (1) A car has a mass of 1000

kg, what is the force required to accelerate the car as much as 0.5 times the acceleration of gravity $g = 9,8 \text{ m/s}^2$? (2) Two boxes connected by a rope that is light and is at rest on the table. The boxes have a mass of 12.0 kg and 10.0 kg. A horizontal force $F_p = 40 \text{ N}$ is given by one person to 10.0 kg box, as shown in Figure 1. Look for: (a) the acceleration in each box, and (b) large rope tension.

Written answers given by subjects with high academic categories as in Figures 1 and 2 for the first question.

1) Diketahui : $m = 1000 \text{ kg}$ $a = ?$
 $g = 9,8 \text{ m/s}^2$
 Ditanya : F

Jawab : Maka percepatannya adalah
 $a = 0,5g$
 $= 0,5 \cdot 9,8 \text{ m/s}^2$
 $= 4,9 \text{ m/s}^2$

Dengan $m = 1000 \text{ kg}$ dan $a = 4,9 \text{ m/s}^2$
 maka,
 $F = m \cdot a$
 $= 1000 \text{ kg} \cdot 4,9 \text{ m/s}^2$
 $= 4900 \text{ kg m/s}^2 = 4900 \text{ N}$
 Jadi besar gaya yang dibutuhkan untuk mempercepat mobil adalah sebesar 4900 N

Figure 1. Document Written by 1T subject to the first question

1 Diketahui massa = 1000 kg percepatan 0,5 kali percepatan gravitasi
 $g = 9,8 \text{ m/s}^2$
 Ditanya : F yang diperlukan?
 Jawab $F = m \cdot a$ untuk percepatan 0,5 kali percepatan gravitasi
 $= 1000 \cdot 4,9$ maka $g \times 0,5 =$
 $= 4900 \text{ N}$ $F = m \cdot a$
 $= 1000 \cdot (9,8 \times 0,5)$
 $= 1000 \cdot 4,9$
 $= 4900 \text{ N}$

Jadi gaya yang diperlukan untuk mempercepat mobil sebesar 0,5 kali percepatan gravitasi adalah 4900 N lebih kecil daripada gaya yang diperlukan untuk $g = 9,8 \text{ m/s}^2$

Figure 2. Document Written by 2T subject to the first question.

Based on documents written answers as shown in Figure 1, showed that the subject 1T is able to provide useful explanations, correct and complete (PS 1) of the question. It can be seen from the completion of the subject matter of the worked out by 1T. the 1T subject mention the mass of the car and acceleration of gravity from the known matter and determine the force required to accelerate the car. The 1T subjects also been able to choose the concepts of physics (PS 2) used in solving problems by using force equation in physics. The 1T subjects been able to do the application of physics (PS 3), and do the mathematical procedures (PS4) in resolving the question. This is evident from how to calculate 1T subjects that has followed the rules of mathematics proper and correct and can write good the unit. Subject 1T also been able is consistently evaluate solutions (PS 5) about its own answer.

Based on documents written answers as in Figure 2 showed that subjects 2T been able to provide useful descriptions (PS 1) of the question. This can be seen from the subject 2T is already capable of organizing the information obtained from this question, the subject of 2T already mention the mass and acceleration of car that have 0.5 times the acceleration of gravity. The subject 2T also been able mention the questions to ask of the question is how big the total force required to accelerate the car. The subject 2T are already able to choose physics concepts and principles appropriate in problem solving (PS 2) in this question It can be seen from the subject 2T in solving this pquestion using an equation force of law newton II. Subject 2T had also able to apply the concepts of physics, and (PS 3) have followed the mathematical procedure for the implementation of the solution (PS 4). Where the subject 2T first calculate the acceleration of the car is obtained from 0.5 times the acceleration of gravity. subsequently calculate

how the total force required to accelerate the car. Subject 2T has been able to use the unit properly because the subject 2T has been able to consistently evaluate solutions (PS 5).

Interviews were conducted in subjects with high academic categories to dig deeper theoretical knowledge they have. The results of the interview by the subject 1T information obtained knowledge of the theory as follows.

P-1 : What is the first thing you think of when reading about this?

1T-1 : Soal ini berbicara tentang gaya suatu benda.

P-2 : Ok. Furthermore, any information that you know in this question and how to solve them?

1T-2 : What I do know of this question is the value of the mass of the car and the car acceleration

obtained from 0.5 times the acceleration of gravity. How to completion using the

equations of Newton second law $F = m.a$.

P-3 : During the process of resolving this question of what you do not encounter obstacles in the

count? What a way to count you've been following the rules of mathematics?

1T-3 : No, because the mass of the car and its acceleration is already known so the solution can be

obtained from the result of the two.

P-4 : What you have to specify a unit precisely the magnitudes of physics known during the

calculation process go on?

1T-4 : hmmm (while thinking) I think already.

P-5 : After working on this question of what you check your work? It could be nothing less from

this completion.

1T-5 : Yes. I am already sure of my answer.

The results of interviews conducted on the subject 2T obtained the following information.

P-1 : When reading about it what do you know?

2T-1 : The magnitude of the mass of the car and the car acceleration obtained from the

acceleration of gravity of 0.5 in which the gravitational acceleration of 9.8 m/s^2 .

P-2 : How do I solve it?

2T-2 : I use the force equation of Newton's law II.

P-3 : Do you find obstacles in resolving this question. What are the obstacles that you find?

2T-3 : No.

P-4 : What you've been following the rules of mathematics during the process of resolving this

question?

2T-4 : Yes. The magnitude of force obtained from the result of the mass and acceleration of the

car.

P-5 : What you've given unit of each physical quantities contained in this question? You've checked back?

2T-5 : Already. The units of the force Newton.

The results of the interview by the subject 1T can be seen that the subject of 1T is good in organizing information (PS 1) obtained in question of force, so that they can choose the concepts of physics (PS 2) and apply a physics approach (PS 3) appropriately in resolving this question. Subject 1T had also good at using mathematical procedures (PS 4) during the process of resolving this question progresses. Subject 1T already sure of the answer because the subject 1T check the answers given to the settlement of this question with good (PS 5).

The results of the interviews conducted to the subject 2T 2T can be concluded that the subject is able to organize information obtained from question statement (PS 1). Subject 2T is right in choosing the concepts of physics (PS 2) and applying concepts of physics

(PS 3) is to settle the question of calculate the magnitude car force. Subject 2T had also good in following the rules of mathematics (PS 4) during the calculation process car force obtained from the result of the mass and acceleration of the car. Subject 2T can provide the answer to this question is logical and consistent (PS 5).

Written answers given by subjects with high academic category for the second problem as in figure 3 and 4. The written answer by the subject of 1T as shown in Figure 3.

2) Diketahui : $m_1 = 10 \text{ kg}$
 $m_2 = 12 \text{ kg}$
 $F_p = 40 \text{ N}$

Ditanya : a) a tiap kotak
 b) T

Jawab : a) pada kotak 1 pada kotak 2

$m_1 = 10 \text{ kg}$	$m_2 = 12 \text{ kg}$
$F_p = 40 \text{ N}$	$F_p = 40 \text{ N}$
$F_p = m \cdot a$	$F_p = m_2 \cdot a$
$40 \text{ N} = 10 \text{ kg} \cdot a$	$40 \text{ N} = 12 \text{ kg} \cdot a$
$a = 4 \text{ m/s}^2$	$a = 3,33 \text{ m/s}^2$

Jadi, percepatan pada kotak 1 sebesar 4 m/s^2 dan percepatan pada kotak 2 sebesar $3,33 \text{ m/s}^2$.

b) $F_p =$

Figure 3. Document Written by the subject question 01T for the second

While the written answer given by the subject 02T such as in Figure 4.

2) Diketahui : $m_1 = 10 \text{ kg}$ $F = 40 \text{ N}$
 $m_2 = 12 \text{ kg}$

Ditanya : a) percepatan pada setiap kotak?
 b) besar tegangan tali?

Jawab :

a) kotak 1 $\rightarrow F_1 = m \cdot a$ kotak 2 $\rightarrow F_2 = m \cdot a$

$40 = 10 \cdot a$	$40 + 40 = 12 \cdot a$
$a = 4 \text{ m/s}^2$	$80 = 12 a \rightarrow a = 6,6 \text{ m/s}^2$

Jadi percepatan masing-masing benda adalah 4 m/s^2 dan $6,6 \text{ m/s}^2$

b) $T = \frac{m_1 \cdot m_2}{m_1 + m_2} \cdot g$

$= \frac{10 \cdot 12}{10 + 12} \cdot 10$
$= \frac{120}{22} \cdot 10$
$= 54,5 \text{ N}$

Jadi tegangan tali adalah $54,5 \text{ N}$.

Figure 4. Documents Written by 2T Subject to the second question.

Based on the documents written answers as shown in Figure 3, shows that the subject 1T already have ability to organize information from the problem statement that is done right (PS 1). This is seen from the subject 1T can mention the masses of the two boxes and a horizontal force given by someone to the box. Subject 1T is not good enough in choosing the appropriate physics concepts in solving the question (PS 2) where the subject 1T can only specify a physics approach to seek acceleration in each box and can not choose physics approach to seeking the great tension rope. This will less good effect the subject 1T in applying physics approach chosen for this condition (PS 3) because of the tension rope can not be known. Subject 1T less good to follow the rules of mathematics proper and correct procedures for the implementation of the solution (PS 4) as seen from the subject of how to calculate the 1T and placement unit for question solving was appropriate. Of the answer sheet is noticeable also that the subject 1T less good at communicating ideas and evaluating the solution in solving this question (PS 5).

Based on the documents written answers in Figure 4 showed that subjects 2T has been able to provide helpful explanations or organize information from the question statement being an exact representation (PS 1). This is seen from the subject 2T already can mention both the mass of the box and the horizontal force given to one of the boxes. Subject 2T is less good in selecting the appropriate physics concepts (PS 2) in resolving the question because the subject 2T can only choose physics approach is used to find the magnitude of the acceleration in each box and less precise in selecting the concepts of physics at rope tension in question. It can affect the subject's ability 2T in applying physics approaches to certain conditions in the question solving. Subject 2T less good in

implementing approaches that have pendekan physics (PS 3) in resolving the question where to find the magnitude of the acceleration in each subject box 2T using force equation. Physics approach chosen subject 2T in determining the magnitude of the tension is less precise rope. Subject 2T is less good in following the rules or procedures of mathematical calculation of the acceleration of each box (PS 4), although the use of force had also the subject 2T is right. Subject 2T is less good in communicating ideas and evaluating the results of the settlement of this question (PS 5).

Results excerpts of an interview conducted on the subject of the 1T-related problems both to obtain information about problem solving ability as follows.

P-1 : What do you know after reading the question of calculating the magnitude of the acceleration in each box and great tension rope?

1T-1 : Of this problem that I know that the mass of each box and the magnitude of the horizontal

force given by someone in one of the boxes. Besides asked about were how to calculate the

acceleration in each rope and how tension the rope.

P-2 : How do you solve that problem?

1T-2 : To calculate the of acceleration on every box I use force equation $F = m.a$ while to calculate

the tension rope, I do not understand.

P-3 : Furthermore, what about the implementation of physics approach do you choose? Do you

have a right to use such an approach.

1T-3 : As far as I such it, so I'm sure will be the equation that I used to solve the question.

P-4 : Try learned back in. Of this question we can see that both of these boxes are connected to

each other, if the rope remains tense and does not extend the second the boxes will have the

same acceleration, so that the formula you select is right, but in practice had a little error.

1T-4 : Yes, I understand.

P-5 : Furthermore, what you already check the answers you give on this question, for example the

use of the appropriate unit or how to calculate the appropriate?

1T-5 : Just a glance, because I focus on doing the next question.

While the results of interviews conducted on the subject 02T obtained the following information.

P-1 : Please provide any information that you get after reading this question?

2T-1 : The mass of each box and its horizontal force.

P-2 : What is the appropriate approach to solve this question?

2T-2 : using force equation.

P-3 : If the rope on both boxes remain tense and does not extend, whether the box will have the

same acceleration?

2T-3 : Of course not. Acceleration owned by the two boxes is different.

P-4 : How do you calculate the magnitude of tension rope? What formula would you use?

2T-4 : This makes me confused. I do not know what to use in calculating the formula where the

rope tension.

P-5 : Did you check the back of your work to ensure the units of the physical magnitudes?

2T-5 : hmmm .. I think yes (confused)

Based on interviews by the subject 1T is known that the subject of 1T is good in organizing information (PS 1) obtained in question of force, so that they can choose the concepts of physics (PS 2) and apply a physics

approach (PS 3) appropriately resolving this question. Subject 1T had also good at using mathematical procedures (PS 4) during the process of resolving this question progresses. Subject 1T already sure of the answer because the subject 1T check the answers given to the settlement of this question with good (PS 5).

Based on the results of interviews conducted to the subject 2T 2T can be concluded that the subject is able to organize information obtained from question statement (PS 1). Subject 2T is right in choosing the concepts of physics (PS 2) and applying concepts of physics (PS 3) is to settle the question of calculate the magnitude car force. Subject 2T had also good in following the rules of mathematics (PS 4) during the process of calculating the car force that is obtained by multiplying the mass and acceleration of the car. Subject 2T can give the answer to this question solving logical and consistent manner (PS 5).

Based on the results of the analysis of written answers and analysis of interviews by subjects with high academic categories, testing the validity of data through triangulation methods. Problem solving ability possessed by subjects with high category received its validity is (1) subject 1T and 2T can organize information very good, (2) the subject of 1T and 2T can choose physics concepts to be used in solving a problem with good, (3) the subject of 1T and 2T can apply physics concepts with good, (4) subject 1T and 2T can use mathematical procedures with good, in showing the interrelation between some of the concepts in solving problems, (5) the subject of 1T and 2T are already good in evaluating his work and stay focused.

Subjects with low academic category also work on the question first given in subjects with high academic category. Written answer given by the subject 1R such in Figure 5.

1) diketahui = $m = 1000 \text{ kg}$
 $g = 9,8 \text{ m/s}^2$
 $h = 0,5 \text{ kali}$
 ditanya = P ?
 jawab = $P = m \cdot g \cdot h$
 $P = 1000 \text{ kg} \cdot 9,8 \text{ m/s}^2 \cdot 0,5 \text{ kali}$
 $P = 1000 \text{ kg} \cdot 4,9$
 $P = 4900 \text{ N}$

Jadi, gaya yang dibutuhkan untuk mempercepat mobil tersebut adalah 4900 N.

Figure 5. Document Written 1R subject to the first question

While the written answers given by the subject 2R can be seen in Figure 6.

1. Diket : $m = 1000 \text{ kg}$
 $g = 9,8 \text{ m/s}^2$
 ditanya $F = \dots ?$
 dijawab $F = m \cdot a$ $\rightarrow \frac{0,5}{9,8}$
 $= 1000 \cdot 4,9$
 $= 4900 \text{ kg}$
 jadi gaya yang dibutuhkan 4.900 kg.

Figure 6. Documents Written 2R subject to the first question

Based on the answers the subject as shown in Figure 5, it is known that the subject 1R less good in organizing information from this question statement (PS 1). Information obtained from this answer sheet only write mass and acceleration of gravity is not to mention the car acceleration. Subject 1R is not good in selecting the appropriate physics concepts in solving this question (PS 2). Subject 1R is also not good approach that selected physics (PS 3, is less good in following mathematical procedure (PS 4) so as to make the subject 1R is not maximized in reevaluate the results of question solving is done (PS 5). It

can be seen from the less precisely the subject 1R in determining the units of the magnitudes of physics.

From the results of the answers to a subject as Figure 6 shows that the subject 2R able of organizing the information obtained from this question statement (PS 1). It can be seen from only mention the subject 2R mass and acceleration of gravity, without mentioning the acceleration of the car which can be obtained from the 0.5 times the acceleration of gravity. Subject 2R is also better at choosing the concepts of physics (PS 2) to be used in resolving this question. So that makes the subject 2R good enough in applying physics approach (PS 3) to solve this question. But the subject 2R already able to use mathematical procedures (PS4) in question solving. Subject 2R deep enough to evaluate the settlement resulting in less consistent in providing answers (PS 5). Excerpts from interviews that been conducted on the subject 01R to the first question as follows.

P-1 : At the time of reading the question, you think question what this is about?

1R-1 : After reading this question talk about the force and acceleration.

P-2 : What information do you get from this question?

1R-2 : On this question known to the mass the magnitude of the car and the car acceleration can be

obtained from 0.5 times the acceleration of gravity.

P-3 : How do I solve it? During the process of resolving this question what you do not find

obstacles in the count? What has followed the rules of mathematics in count?

1R-3 : Using the force equation for the known mass and acceleration.

P-4 : What you are correct in applying the equations in the question? What has followed the rules of mathematics in count?

1R-4 : Hopefully correct and I believe the application of the equation that I use is appropriate.

P-5 : After working on this question, what you check the placement of units of each the magnitudes of physics in the question?

1R-5 : Yes. I check back as the value of physical magnitudes without a unit that does not mean anything.

While the results of an interview has been conducted on the subject 02R to the first question as follows.

P-1 : After reading about this, what you already have shadow about this question will be resolved

such what?

2R-1 : Yes.

P-2 : How do you estimate and please explain?

2R-2 : Mass and acceleration are known. the question is talking about force.

P-3 : How do you determine the acceleration of a car? On your answer sheet directly provide value

without outlining the calculation process.

2R-3 : (Looks confused and does not answer)

P-4 : Try to read the back this question. In this question, the acceleration of a car obtained from

0.5 times the acceleration of gravity. Please reworked.

2R-4 : (By doing) yes, now I understand..

P-5 : After working on this question what you check your work? It could be nothing less from this

completion.

2R-5 : I have not had time to check it out, so I admit there are shortfall in resolving this question.

Based on the interview above show that the subject 1R has been able to organize the information (PS 1) of the statement given

question of how to calculate the magnitude of the acceleration in each rope and rope magnitude of the tension. Subject 1R is less good in choosing the concepts of physics (PS 2) so that the application of the concept of physics (PS 3) unfavorable affect on the lack of good subjects 1R in using mathematical procedures (PS 4) on the completion this question. Subject 1R is less good in providing answers because many of the answers are not clear and consistent (PS 5).

Based on the interview above is already known that the subject 2R good at giving useful explanations (PS 1) of the information obtained from the question statement. Subject 2R is less good in choosing the concepts of physics (PS 2) used in question of calculating the magnitude of the acceleration and the tension rope so that the application of the concept of physics (PS 3) also have problems especially in determining the magnitude of the tension rope. Subject 2R less good at using mathematical procedures (PS 4) and in providing answers because there are still many errors, especially errors in the writing unit so as to make the answers given are unclear and inconsistent (PS 5).

The second problem is also given to subjects with low academic category. And written answers given by the subject 1R as found in Figure 7.

2) diketahui : $m_1 = 12,0 \text{ kg}$
 $m_2 = 10,0 \text{ kg}$
 $F_p = 40 \text{ N} = 10,0 \text{ kg}$
ditanya : a) a gel sekap kotak ?
b) besar tegangan tali ?
Jawab : a) $F = m_1 \cdot a$
 $40 \text{ N} = 12,0 \text{ kg} \cdot a$
 $a = \frac{40 \text{ N}}{12,0 \text{ kg}} = 0,3$ jadi : percepatan pada kotak pertama sebesar 0,3 dan pada kotak kedua sebesar 0,25.
 $F = m_2 \cdot a$
 $40 \text{ N} = 10,0 \text{ kg} \cdot a$
 $a = \frac{40 \text{ N}}{10,0 \text{ kg}} = 0,25$
b) $\frac{m_1 + m_2}{m} = \frac{F}{x}$
 $\frac{12,0 + 10,0}{10,0} = \frac{40 \text{ N}}{x}$ jadi : besar tegangan tali yang dibutuhkan adalah 18,1
 $\frac{22,0}{10,0} = \frac{40 \text{ N}}{x}$
 $22,0 \times = 400 \text{ N}$
 $x = \frac{400 \text{ N}}{22,0} = 18,1$

Figure 7. Written Document 01R subject to the second question

2R-2 : I use the force equation to solve this question. Acceleration is obtained from the quotient between force and mass known box.

P-3 : Whether the speed of each box is different?

2R-3 : No.

P-4 : In the completion this question, if you write a unit of each physical magnitude that exist?

2R-4 : Yes, but it may not be correct.

P-5 : After working on this question, what you check the placement of units of each the magnitudes of physics in the question?

2R-5 : No.

Based on the results of interviews showed that subjects has been able to organize information 1R (PS 1) of the statement given question of how to calculate the magnitude of the acceleration in each rope and rope magnitude of the tension. Subject 1R is less good in choosing the concepts of physics (PS 2) so that the application of the concept of physics (PS 3) is less good, so it will affect the less well the subject 1R in using mathematical procedures (PS 4) on the completion this question. Subject 1R is less good in providing answers because many of the answers are not clear and consistent (PS 5).

Based on the results of interviews showed that subjects 2R already good at giving useful explanations (PS 1) of the information obtained from the question statement. Subject 2R is less good in choosing the concepts of physics (PS 2) used in question of calculating the magnitude of the acceleration and the tension rope, so that the application of the concept of physics (PS 3) also experienced problems especially in determining the magnitude of the tension rope. Subject 2R less good at using mathematical procedures (PS 4) and in providing answers because there are still many errors, especially errors in the writing unit, so as to make the answer given unclear and inconsistent (PS 5).

Based on the results of the analysis of written answers and analysis of interviews by subjects with low academic categories, testing the validity of data through triangulation methods. Problem solving ability possessed by subjects with low category received its validity is: (1) subject 1R has been good in organizing information, while the subject 2R is less good in organizing information, (2) the subject 1R and 2R less good in choosing physics concepts to be used in solving the problem, (3) the subject 1R and 2R less good in applying concepts of physics, (4) the subject 1R and 2R is less good in following mathematical procedure, (5) the subject 1R and 2R less good in evaluating his work, and less focused.

DISCUSSION:

This research aims to develop instruments to describe the physics student problem solving ability and implement the results of the instrument development problem solving ability of students of physics.

Based on the description and analysis of data for the PS-1 by subjects with high academic category is obtained that the subject 1T been able to provide useful explanations, correct and complete (PS 1) of the question. Subject 1T can already mention the mass of the car and the acceleration of gravity from the known question and determine the force required to accelerate the car. For subjects 2T been able to provide useful explanation of the question. This can be seen from the subject 2T is already able to organize the information obtained from this question, the subject of 2T already mention the mass and acceleration of cars that have 0.5 times the acceleration of gravity. Subject 1R known that the subject is less precise in organizing information from a statement about this. Information obtained from this answer sheet only write mass and acceleration of gravity is not to mention the car acceleration. From the results of the written

answer sheet showed that subjects 2R less capable of organizing the information obtained from this question statement. This can be seen from only mention the subject 2R mass and acceleration of gravity alone, without mentioning the acceleration of the car which can be obtained from the 0.5 times the acceleration of gravity. Herausgeber (2013) explains that Students often do well on traditional textbook style problems without actually understanding the concepts. Problems of a different type are needed to show the students as well as the instructor how well they understand the underlying physics concepts. The ability of students to use existing information to determine what should be done in a particular situation, referring to the effort required of students in determining solutions to the problems faced (Silay, 2008 and Selcuk, 2008).

Based on the description and analysis of data, subject 1T seen that this subject has been able choose the concepts of physics (PS 2) in selecting the physics concepts used in solving question by using force equation in physics. Subject 2T are already able to choose physics concepts and principles appropriate in solving problems in this question. This can be seen from the subject 2T for solving this equations using force of Newton's second law. Subject 1R has been able to choose the appropriate physical approach in solving this question. Subject 2R less precise in choosing physics approach to be used in resolving this question. Relation to the matters, Brotosiswoyo (2000) explains that physics is intended for those who enjoyed the activities that explore new information can be added to the existing physics at this time. Learning physics equal with the development of problem solving ability and achievement is measured by a number of problems that can be solved properly by learners (Bascones, 2007).

Based on the description and analysis of the data, it appears that the subject of 1T has been able to carry out the implementation of physics (PS 3). This is seen from the application of physics approach chosen to resolve this question is appropriate. Subject 2T has been able to apply the concept of physics. Subject 1R has been able to apply physics approach chosen. Subject 2R disadvantaged in applying physics approach to resolve the question of force. Brotosiswoyo (2000) explains that physics is seen as a collection of knowledge about symptoms and temperament of nature that can be used to help develop fields professions such as medicine and engineering sera physics is seen as a work discipline that can produce a number of skills generic to equip working in various professions wider, Further explained that We developed an innovative sequence-based clicker methodology framework to enhance student conceptual understanding and flexible application of core ideas in physics (Ding, 2012).

Based on the description and analysis of the data, it appears that the subject of 1T has been able to perform mathematical procedure (PS 4) in resolving the question. This can be seen from the way of calculating the subject 1T already follow the rules of mathematics proper and correct and can write with good unit. Subject 2T has been able to follow the mathematical procedures for the implementation of the solution. Where the subject 2T first calculate the acceleration of the car is obtained from 0.5 times the acceleration of gravity. Next calculate how the total force required to accelerate the car. Subject 1R is less precise in following mathematical procedures during the process of resolving question of force. Subject 2R already able to use mathematical procedures in question solving. Reif (1995) explains that some of the indicators that possessed by students who have the ability to describe knowledge among others to

develop knowledge quantitatively and qualitatively; describe knowledge using symbols and laws; describe knowledge by utilizing mathematics and logic. Further Rahmah (2007), wanhar (2008), Lukyto (2009), and Haryadi (2015) in his research show that the mathematical ability of students to contribute to students' ability to solve the questions of physics. Basically people who have a high mathematical ability would easily concepts of physics and solve the questions of physics calculations. Relation to the matters Meltzer (2003) found a positive correlation between the value of physics in college with math skills pretest value given on / or before the lecture.

Based on the description and analysis of the data, it appears that the subject 1T been able to consistently evaluate solutions (PS 5) against its own answer. Subject 2T has been able to use the unit properly because the subject 2T has been able to consistently evaluate solutions. To subject 1R is not maximized in reevaluate the results of question solving is done. It can be seen from the less precisely the subject 1R in determining the units of the magnitudes of physics. Subject 2R less capable of evaluating the completion resulting in less consistent in give an answer. Sabella and Redish (2007) explains that the physical education teachers and researchers need to pay attention to the issues of how the acquisition and use of knowledge structure.

CONCLUSIONS:

Based on the background of the problem and the results of this study concluded that the evaluation instrument developed to describe the problem solving ability of students, both high and low category category.

REFERENCES:

- 1) Campbell, J. (2007). "Using Metacogs to Collaborate with Students to Improve Teaching and Learning in Physics". Tersedia
- 2) Ding. Lin. (2012). Teaching Undergraduate Physics through a Research-based Clicker Methodology. Paper presented at the NSEUS national conference on Research Based Undergraduate Science Teaching Conference II, Bryant Conference Center, University of Alabama.
- 3) Heller, K., & Heller, P. (1999). Problem-Solving Labs. Introductory Physics I Mechanics. Cooperative Group Problem-Solving in Physics.
- 4) Herausgeber, Bernd Zinn, Rafl Tenberg (2013). A Practical Application of Physics Education Research-informed Teaching Interventions in a First-year Physics Service Course. Journal of Technical Education (JOTED).
- 5) Kuo, V. (2004). An Explanatory Model of Physics Faculty Conception About the Problem Solving Process. University of Minnesota: Ph. D. Thesis.
- 6) Krulik, S., & Rudnick, J. A. (1996). The New Source Book for Teacing Reasoning and Problem Solving in Junior and Senior High School. Boston: Allyn and Bacon.
- 7) Lincoln, Y. S., Guba, E. G., (1985). Naturalistic Inquiry. Sage Publications. London.
- 8) Lukito, Tatas. 2009. Hubungan Antara Kemampuan Dasar MAtematika Dan Kebiasaan Belajar Peserta Didik Dengan Prestasi Belajar Fisika Pada Bab Cahaya. UNM.
- 9) Lynn, Jennifer. (2009). Development and Validation of a Physics Problem-Solving Assessment Rubric. The University of Minnesota.
- 10) Malone, L. K. (2006b). "The Convergence of Knowledge Organization, Problem Solving Behavior, and Metacognition Research with

- The Modeling Method of Physics Instruction” – Part I. Journal Physics Teacher Education. Online, 4(1).
- 11)McGregor, D. (2007). Developing Thinking Developing Learning : A Guide to Thinking Skills in Education Beegorkshire: Open University Press, Mc Graw-Hill.
- 12)Popov, Oleg and Rolf Engh. (2006). Outdoor Activities and An Interactive Website as Tools For Facilitating Learning Physics In Teacher Education.
- 13)Prabowo, 2011. Metodologi Penelitian (Sanis dan Pendidikan Sains). Penerbit Unesa University Press. Surabaya
- 14)Rahmah. (2007). Hubungan Antara Kemampuan Matematika Dan Motivasi Belajar Dengan Prestasi Belajar Fisika Peserta Didik Kelas X SMA Negeri Malang.
- 15)Reif. Frederick. (1995). Understanding and Teaching Important Scientific Thought Processes. Journal of Science Education and Technology vol 4 No 4
- 16)Sabella, M., & Redish, E. (2007). “Knowledge activation and organization in physics problem-solving”. Jurnal Organization of Knowledge. Pp. 1-14.
- 17)Satori, D. dan Aan K. 2009. Metodologi Penelitian Kualitatif. Alfabeta. Bandung.
- 18)Solaz-Portolés, J. J. & Sanjosé, V. (2007). Representation in Problem Solving in Science: Direction for Practice. Asia Pasific Forum Science Learning and Teaching. Volume 8, Issue 2, Article 4, p.1.
- 19)Solso, R.L., Maclin, O.H., Maclin, M.K. (2008). Cognitive Psychology, Eight Edition. Boston: Pearson Educational.