Using two tier based concept test to analysis profile of student understanding on the concept of simple harmonic motion

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Abstract. The purpose of this study was to analyze students understanding profile about simple harmonic motion conceptual. The subject of this study were eleventh grade student of sciences class in Surakarta2 State Senior High School with 90 students whose registered as student in the 2018/2019 school year. Sampling in this study used random sampling technique. To analyze students understanding profile used instrument of two tier test with 20 item. Instrument consists two level, first level is multiple choice questions and the second level is open ended free response question which is the reason of student’s answer to the first level questions. The result of this study show that 12,9% of students understanding the concept of simple harmonic motion, 16% of students understand in part, 18,2% of students show misconception, 31,5% of students show specific misconception, and 16,5% of students didn’t understand the concept. The highest concept understand was in concept relation of velocity, angular velocity, displacement and acceleration in simple harmonic motion with 41,11%, and the lowest was in definition of simple harmonic motion with 0,74%.

1. Introduction

Simple harmonic motion is a physics concept that is important for students and has use in everyday life so that recognition of this concept is very important. Simple harmonic motion appear in various branches of classical physics, engineering and in modern physics [1,2]. Simple harmonic motion are considered difficult by students. Difficult material makes students not understand the concept and experience misconceptions. Students whose misconceptions tend not to change their way of thinking after the learning process occurs [3].

To improve the quality and effectiveness of physics learning, information about students' understanding and misconceptions of physical material is needed [4]. Therefore, many researchers have examined the students' understanding of the concept of physics [5-10]. The results of these studies mostly show that the understanding of physics concepts is still relatively low and have misconception, including those of simple harmonic motion material [11-14]. To identify understanding and misconceptions in students can use Two tier instruments. Two tier tests are one form of diagnostic tests that can be used to measure student understanding. Two tier test is a form of test with two stages which at the first stage is a multiple choice question and the second stage is the reason for the answer at the first stage [15]. In general, two-tier tests are described as diagnostic tests with the first in the form of multiple choice questions and the second stage in the form of multiple choice which is the reason for the answer at the first stage [16]. Student answers are considered correct if both questions
are answered correctly. Instrument two tier tests are advances in the field of evaluation which involve reasons or thoughts behind student answer choices [17]. Two tier tests, for students it is easier to answer questions and more practical. Whereas for teachers, two tier tests can reduce students to guess answers, and easy for scoring [18].

2. Methods
The method used in this study is qualitative descriptive. Qualitative descriptive method was chosen to identify students' misconceptions and understanding of simple harmonic motion material. The research subjects were 90 students of class XI IPA in Surakarta Public High School 2 in the 2018/2019 school year. Sample selection is done by random sampling.

The instruments used in the study are two-tier or two-tier instruments. The first stage on the instrument is a multiple choice question and on the second stage is an open answer. The instrument consists of 20 item questions from 7 indicators on simple harmonic motion material. The instrument has been validated by experts and the results of the validation analysis show that the instrument is valid according to the Aiken formula with index value $> V$ table (1). The reliability of the instrument according to Person reliability shows a value of 0.93 with a high category. Whereas, the reliability of item items shows a value of 0.61 with a moderate category. The problem indicator used in the study is shown in Table 1.

| Material Concept | Item question |
|------------------|--------------|
| The definition of simple harmonic motion | 6,7,19 |
| The magnitude of simple harmonic motion | 13,15 |
| The relationship between speed, angular velocity, amplitude and acceleration | 1,4 |
| The relationship between rope length, mass, gravitational acceleration to frequency | 2,3,9,18,20 |
| Relationship between spring constant, mass, amplitude to frequency | 5,10,11,12 |
| Energy in simple harmonic motion | 17 |
| Restoration force | 8,14,16 |

Student answers are analyzed based on the answer key and rubric assessment that has been made by the researcher. The answer key and rubric of the assessment have been consulted by experts first. Students' understanding is shown by students' answers in the first and second tier. Student answers are classified into several modified categories of categories developed by Tarakci [19]. Table 2. Shows categories of classifications of student understanding

| Combination answer | Category |
|--------------------|----------|
| First tier | Second tier |
| True | False | misconception |
| False | True | misconception |
| True | True (not perfect answer) | Partial understanding |
| True | True (perfect answer) | Understanding |
| False | False (related) | Specific misconception |
| False | False (not related) | Do not understand |
| No answer | No answer | Do not understand |
3. Results and Discussion

Two tier is a test instrument consisting of two stages, the first stage is a multiple choice question and the second stage is the reason for the answer from the first stage. The instruments used in the research are the development of instruments developed by Treagust. The instrument used at the first stage is a multiple choice question and at the second stage is an open reason. The second stage uses open reason because in the instrument two tier test with multiple choice forms can provide clue correct answers to students[20]. So that on the second stage question, students can choose logical choices and relate to the first stage question [21]. Based on the results of the analysis of students' understanding of simple harmonic motion material using the two tier test data obtained as follows:

| Table 3. Percentage of Students' Understanding of Simple Harmonic Motion Material |
|---------------------------------|------------------|
| Level of concept understanding  | %                |
| Understand the concept          | 12,9             |
| Understand in part              | 16               |
| Misconception                   | 18,2             |
| Specific misconception          | 31,5             |
| Do not understand               | 16,5             |

Based on Table 3 it is known that out of 90 students there are 12.9% students who understand the concept of simple harmonic motion, 16% of students still understand partially, 18.2% students misconception, 31.5% students have special misconceptions and 16.5% students still not understand the concept of simple harmonic motion. Based on this analysis there are still many students who experience misconceptions, special misconceptions and have not understood the concept of simple harmonic motion material. The misconception must be immediately identified and the teacher must reconfirm the material that has been submitted to the student. In addition the teacher must make the learning process better so that the material conveyed can be understood by students. Table 4 shows the percentage percentage of students' understanding on each indicator used in simple harmonic motion material.

| Table 4. Percentage of Students' Understanding Each Indicator |
|--------------------------------------------------------------|
| Material Concept                                             | %    |
| The definition of simple harmonic motion                     | 0,74 |
| The magnitude of simple harmonic motion                      | 18,89|
| The relationship between speed, angular velocity, amplitude and acceleration | 41,11|
| The relationship between rope length, mass, gravitational acceleration to frequency | 2,67 |
| Relationship between spring constant, mass, amplitude to frequency | 26,57|
| Energy in simple harmonic motion                             | 1,1  |
| Restoration force                                            | 2,96 |

Based on the data obtained from the analysis, there are still many students who still do not understand each indicator on simple harmonic motion material. The highest understanding of students is in the indicator of the relationship between speed, angular velocity, amplitude and acceleration with the number 41.11%. While there are still many indicators that still have a percentage below 10%. This is due to several reasons, namely at the first level students choose the right answer and at the second
level students answer correctly but not the perfect answer. So as to make students fall into the category of partial understanding.

Table 5. Students' Perceptions of The Concept of Simple Harmonic Motion

| Material Concept                                      | Misconception                                                                 |
|-------------------------------------------------------|-------------------------------------------------------------------------------|
| The definition of simple harmonic motion            | The direction of acceleration is in the same direction of displacement       |
| The magnitude of simple harmonic motion              | Not yet able to distinguish between phase angles and phase constants        |
| The relationship between speed, angular velocity,    | the smaller the amplitude, the greater the speed of simple harmonic motion   |
| amplitude and acceleration                           |                                                                                |
| The relationship between rope length, mass,          | The mass affects the amount of frequency                                     |
| gravitational acceleration to frequency               |                                                                                |
| Relationship between spring constant, mass,          | Frequency is influenced by amplitude                                          |
| amplitude to frequency                               |                                                                                |
| Energy in simple harmonic motion                     | The spring potential energy is directly proportional to the amplitude       |
| Restoration force                                     | The greater the recovery force, the greater the spring constant              |

4. Conclusion

Based on the results of the study it can be concluded that using the two tier test instrument with the second level using open reasons can be used to measure students' understanding and can be used to identify student misconceptions. From the results of the study it was found that there were still many students who experienced misconceptions, specific misconception and understood partially in the concept of simple harmonic motion. Students with partial understanding categories were due to several reasons, namely at the first level students choose the right answer, but at the second level students answer correctly but not the perfect answer. So as to make students fall into the category of partial understanding. For students who experience misconceptions and special misconceptions must be identified immediately and the teacher must reconfirm the material that has been delivered to students. In addition, the teacher must make the learning process better so that the material conveyed can be understood by students, because students whose misconceptions tend not to change their way of thinking after the learning process occurs

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