The use of astronomy questions as an instrument to detect student's misconceptions regarding physics concepts at high school level by using CRI (Certainty of Response Index) as identification methods

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Abstract. The aim of this research is to detect misconceptions in the concept of physics at high school level by using astronomy questions as a testing instrument. Misconception is defined as a thought or an idea that is different from what has been agreed by experts who are reliable in the field, and it is believed to interfere with the acquisition of new understanding and integration of new knowledge or skills. While lack of concept or knowledge can be corrected with the next instruction and learning, students who have misconceptions have to "unlearn" their misconception before learning a correct one. Therefore, the ability to differentiate between these two things becomes crucial. CRI is one of the methods that can identify efficiently, between misconceptions and lack of knowledge that occur in the students. This research used quantitative-descriptive method with ex-post-facto research approach. An instrument used for the test is astronomy questions that require an understanding of physics concepts to solve the problem. By using astronomy questions, it is expected to raise a better understanding such that a concept can be viewed from various fields of science. Based on test results, misconceptions are found on several topics of physics. This test also revealed that student's ability to analyse a problem is still quite low.

1. Introduction

Based on the previous research, misconception has become one of the most possible reasons why students found some difficulties in learning physics. In the learning process, most of the students usually come to the class with some ideas or concepts that they have obtained from their previous learning and experience. Sometimes the ideas or concepts that they have is different from the ideas that have been agreed by the expert in the field at the current time, and this is what we call as misconception.

Some experts believe that misconceptions can interfere with the acquisition of new understanding and integration of new knowledge or skills. One of the reasons is because the student will try to relate a new concept that they get with a misconception that they have, which will lead to another misconception. That is the primary reason why misconceptions become something important that need to be solved.

While lack of knowledge can be corrected by the next instruction and learning, students that have misconception need to unlearn those misconceptions first before learning a correct concept. Therefore, the ability to differentiate these two things become crucial.

Several methods can be used to differentiate between students that have lack of knowledge and the students that have misconceptions. One of the methods is Certainty of Response Index (CRI). CRI method is a misconception detection method, which use a form of multiple choice questions where the respondents have to indicate, on a scale of 0-5, how certain they are that their one choice is correct [4]. The advantages of this method are in terms of ease, accuracy and speed the process for identifying and analyzing the data. Since one of the purpose of this research is to detect misconception, we found that this method is really compatible with our research.

2. Certainty of response index method

This method is mostly used in psychology test. In 1999, Hasan modified this method and used it for educational research. In this method, the respondents will do their own assessment regarding their certainty of their answer. The scale of certainty is in 6-point scale (0-5) where 0 indicates totally guessed answer (no knowledge) and 5 indicates a complete confident of an answer.

Regardless the answer was correct or wrong, the low CRI value (0-2) will indicate guessing which implies a lack of knowledge. While a high CRI (3-5) shows a high degree of confidence regarding a concept that they have. If the students with high CRI give a right answer, then we can conclude that they have a correct concept. But if the answer falls to an incorrect one, the high CRI will indicate that the students have a misconception.

3. Astronomy questions as a testing instrument

A concept in science should be understood holistically. When students learn about a concept, we want them to understand a concept not only from one field of science, but also to look at it in the various fields of science. Because the truth is, a concept actually can be applied in many fields of science. For example, the concept of energy, where energy cannot be created and destroyed, but can change from one form of energy into another form, is not only applicable in the domain of physics, but also applicable in biology, chemistry and astronomy. If students understand this, then these students will be able to answer questions related to the concept, although the question was asked from the different view of field in science.

On the other hand, astronomy has a special charm to attract student's interest. Based on experience, we all know that the students will be amazed when they see some amazing pictures that relate to astronomy. By this, astronomy could be a way to attract students so that they can get interested in various fields of science.

Based on this, we decide to use astronomy questions to detect misconception in physics at high school level. This is important to note that, there is no prior knowledge in astronomy needed to answer the question. If students understand the concept of physic (that has been taught), they can answer the question.

4. Method

In this research, we use a quantitative-descriptive method with ex-post- facto research approach where we will only detect the misconception without looking the reason why the student has these misconceptions. The numerical data obtained will be analyzed statistically, and then we will take a conclusion from it.

The research was conducted in one university at Makassar (first year students), 2 schools in Pekanbaru (accreditation A), and 4 schools in Bandung (accreditation A and B), with total subjects 784 students. The concept that we tested is the concept that has been taught in the second semester on 1st, 2nd and 3rd grade. The instrument (the questions) for this research has been validated by experts in the field, in this case experienced teachers and the lecturer of ITB.

5. Result

We realize that the research that we have done is not completely perfect, but we can use this data as a first step to find out the common topic where the students have a misconception. The data that we have

can also be used to find out the common problem that the students have in learning, especially in physics. Based on the result of our research, we can conclude that the use of astronomy question as a testing instrument to detect misconception in physics was quite successful. Below is the result regarding the percentage of student's that have misconception in each grade:

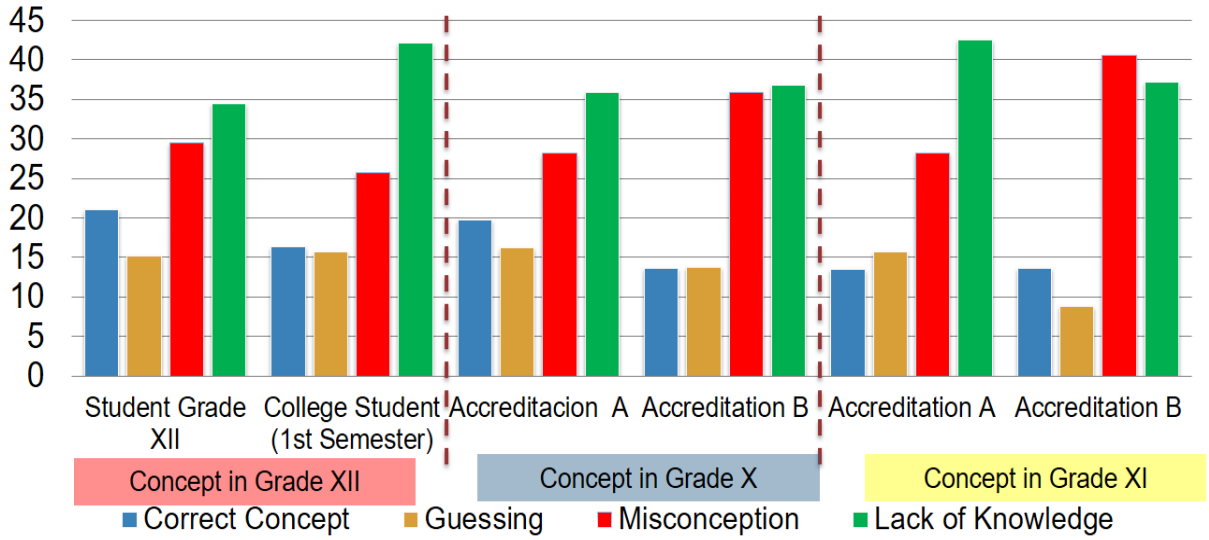

Figure 1. This graph shows a comparison between student in a school with accreditation A and school with accreditation B. The bar indicates a percentage of students that have a misconception as well as the students that have lack of concept and the students that have a correct concept

Based on the result, we can see that students in a school with accreditation B have a higher misconception than students in school with accreditation A. Several concepts that have a higher percentage of misconception listed as below:

1. The relation between light scattering and wavelength.
2. The relation between the energy of the radiation with a radius of the object.
3. The relation between the maximum intensity of radiation with a wavelength
4. The relation between the periods, the linear velocity and angular velocity in circular motion
5. Factors that cause objects to float and sink
6. The relationship between temperature, pressure, and volume
7. Reflection
8. Angular velocity of the rigid body rotation
9. The wave nature of light (scattering, flexing and polarisation).
10. Things that caused the greenhouse effect

In figure 1 above, a part of misconception percentage, we also notice that the percentage of students that have lack of knowledge is in a bigger number (we also include guessing as a lack of knowledge). Since the questions we have given are related with concepts of physics that they have learnt on the previous semester, we suspect that students are not having a full understanding of the concepts.

Although the main purpose of this research is to detect misconception, we also discover other things. In the test, we also put some detractors in the options to see how well is the student understand the concept. We also use 2 questions that have different form, for example; one is a calculation and the other one is comparison questions, but both of the questions have the same concept. By using these detractors and different form of a question for the same topics, we found out that students have another problem as below:

1. Students tend to memorize both concepts and formulas, without understanding them.
2. The student's ability to analyze a problem (questions) is still quite low.

3. Most students have some difficulties to read the relationship between the quantities in an equation/a formula.
4. Most students are not able to understand the relationship of the quantities in the form of graphs
5. Several students tend to memorize a unique number without understanding it
6. Students are not having a fully or complete understanding of a concept.

References

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