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Misconceptions of Prospective Physics Teacher Students on the Period of Lunar Phases

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Abstract. This study aims to analyze the misconceptions of prospective physics teacher students on the topic of the period of lunar phases. The sample of the research comprised 64 participants of physics teacher students at Universitas Sriwijaya, Indonesia. The instrument used to collect the data was the LPCI (Lunar Phases Inventory Concept) diagnostic test modified consisted of 20 multiple choice questions accompanied by open reasons and equipped with CRI (Certainty of Response Index) with a scale of 0-5. Such a test is also known as a three-tier test. It was found that the average score of students from the test results was quite good, namely 58.33%. In addition, it was also obtained that 33.85% of students experienced misconceptions on the material of the period of the moon's cycle phases, 33.33% of students did not understand the concept, and as many as 32.81% of students understood the concept correctly. Instructors should consider the students' misconceptions to develop appropriate teaching strategies.

INTRODUCTION

Nowadays, physics lessons are very influential in the development of education in Indonesia. Mundilarto [1] interprets physics as one of the sciences that explores quantitative understanding for several indications or natural processes and material properties and applications. Murdani [2] further explained that facts, data, law, concepts, principles, rules, theories, and models are part of the product of physics. He teaches physics lessons in order to equip students with knowledge and understanding of concepts that will later affect science and technology. However, there are still many college student stigmas that say that physics is an uninteresting and difficult subject [3]. In physics lessons, Understanding physics is one aspect that must be met so that students are able to understand the subject well. Lack of understanding of concepts and finding various misconceptions in science learning are common problems that continue to occur [4]. The various understandings of concepts that students have while in college are of course innate when they are in school. Another's expert revealed students' misconceptions can come from the previous learning process [5]. College Students who experience misconceptions are college students who cannot explain the meaning of the concept correctly. Preconceived notions or conceptual who revealed that misconceptions can occur when college students get the results of the learning process at the previous level of education.

Misconceptions are a serious problem that causes the low quality of educational outcomes [6]. Misconceptions will hinder the student's learning process [7]. Furthermore, misconceptions describe a problem that is sometimes experienced during learning that can be overcome by emphasizing the specific procedures of the concept being studied [8]. Errors and mistakes in capturing the meaning and meaning of the material studied will lead to misconceptions [9]. The concepts used in the learning process itself will certainly be useful in mastering the concepts and their interrelationships in solving problems in everyday life. Misconceptions in physics learning are very resistant if they are not considered carefully by the teacher [10]. Based on the theory of conceptual change misconceptions will not be resolved unless handled properly [11]. Therefore, physics education college students who will later serve as prospective physics teachers must master the concepts of physics which will affect the achievement of educational goals in the teaching and learning process.

Based on teaching experiences, misconceptions often occur in earth and space science (ESS) materials. There are still many people who do not yet have an understanding of the concepts of earth and astronomy [12]. This is supported by the existence of several studies on several topics in ESS, one of which is a longitudinal study of changes in the understanding of teacher candidates' understanding of the moon phase by Trunder, Atwood, and Christopher and Kanli that identified the misconceptions of prospective teachers about the basic concepts of astronomy and found that prospective teachers experienced extraordinary misconceptions, especially about the phase of the moon, and the phase of the moon in eclipse conditions [13, 14]. The research also revealed that students have a conception of the moon not rotating because the part of the moon that is visible from the earth is always the same, the moon is stationary or does not move like the sun, a large celestial body will provide a greater attraction [15]. Many university professors have the notion that errors in understanding student concepts are associated with a lack of understanding by their educators. College students must correct their mistakes first in order to teach the concept later correctly [16]. Therefore, it is necessary to conduct research to identify misconceptions by using appropriate instruments and methods.

METHOD

The method used in this research is descriptive research with a quantitative approach. To obtain an overview of the actual situation related to the subject to be studied to obtain answers of the questions, descriptive and quantitative data were used [17]. The variable in the study is determined by the researcher to be studied and then drawn conclusions [18]. In this study, what is meant by misconception is a student's conception of the moon phase material concept of the lunar phase cycle orbit period in the ESS course that is not in accordance with the scientific description or not in accordance with the concept of the field. This variable is the percentage level of misconceptions by giving multiple-choice tests taken from physport by using the LPCI questions (Lunar Phases Concept Inventory). LPCI (Lunar Phases Concept Inventory) is a twenty-item multiple-choice question designed to assess students' understanding of the phases of the moon [19]. The use of this question is accompanied by open reasons that are equipped with a confidence index. Then the average student confidence index was calculated for right and wrong answers and the right and wrong answer fractions to find out the conception profile of college students on the moon phase material at ESS. The number of subjects is less than 100, it is better to take all so that the research is a population study [20]. But if the number of subjects is large, it can be taken between 10-15% or 20-25% or more. In quantitative research, the population is defined as a generalization area consisting of objects/subjects that have certain qualities and characteristics that are determined by researchers to be studied and drawn conclusions [21].

The research subjects used based on the explanation above were college students of Sriwijaya University physics education study program, comprised of 64 college students. The test used in this study was in the form of multiple-choice with open reasons, equipped with a CRI confidence index to identify misconceptions of prospective physics teacher students on the lunar phase. One of the instruments that can identify misconceptions experienced by students is known as the Certainty of Response Index or in short CRI [22]. The test instrument used is LPCI (Lunar Phases Concept Inventory) whose translation has been validated by a physics lecture of Sriwijaya University. The test results data in this study were obtained by analyzing the answers and reasons chosen by students for each item of the concept to be studied so that researchers could review whether or not there were misconceptions experienced by students.

To find out how many students have misconceptions in this study, it was used three-tier test namely a diagnostic test with three stages. The first stage is that students are asked about their knowledge in the form of multiple-choice questions. Next is the second stage, at this stage, college students are asked to provide reasons related to the answer choices in the first stage. The last is the third stage which contains the level of college student confidence in the answer choices chosen in the previous stages. A diagnostic test that can show how college students draw conclusions in the thought process to answer each question being tested is a better diagnostic test than just showing college students not understanding certain concepts [23]. This diagnostic test also shows how the level of accuracy is based on the error information that has been made by college students.

Analysis of the test data using the score. The part to be studied lies in the scores obtained by college students based on their ability to answer the multiple-choice questions given. By using multiple-choice tests with open reasons, respondents have the freedom to express the reasons for each answer they choose and can see the consistency of students in answering questions. Students are required to explain the reasons why they chose the answer. This way allows college students to pay more attention and they try to explain the observed phenomena according to their conception [24]. Thus it can be easily identified alternative conceptions that college students have based on all the reasons for each answer item.

Besides choosing answers to multiple-choice questions, college students also provide an index or description of their beliefs about the concepts, laws, theories, or knowledge they use in determining the answers they choose, usually in the form of a scale from 0 to 5. Table 1 CRI response scale criteria that can describe respondents' beliefs about alternative answers [25].

TABLE 1. Response Scale and CRI Criteria [26]

Scale Response	Criteria CRI	Percentage Guess (%)
0	Tottaly Guess Answer	100
1	Almost Guess	75-99
2	Not Sure	50-74
3	Sure	25-49
4	Almost Certain	1-24
5	Certain	0

The CRI value used is taken from the average CRI of each college student. For a given question, the total CRI for incorrect answers is obtained by adding up the CRI and all respondents' incorrect answers to the question [27]. The average wrong answer for a given question is obtained by dividing the number mentioned above by the number of respondents who answered incorrectly for the question, and vice versa for the correct answer. CRI was developed into a modified CRI which contains the level of student confidence in answering the questions given along with the reasons for choosing the answers. The provisions for the average CRI can be seen in table 2.

TABLE 2. Terms of Average CRI [28]

Answer Criteria	Low CRI (< 2.5)	High CRI (> 2.5)
Correct	The correct answer with a low CRI means that the student does not know draft (lucky guess)	The correct answer with a high CRI score means knowing good concept
Wrong	The wrong answers with low CRI scores mean that students don't know draft (lucky guess)	The wrong answer with CRI score high means that students have misconceptions

The steps to analyze the test data of research results are:

1. Determine the average CRI of correct and incorrect answers using the formula:

$$R_b = \frac{\sum CRI_b}{n_b} \text{ and } R_s = \frac{\sum CRI_s}{n_s}$$

Information :

R_b = average CRI for correct answers

n_b = number of college students who answered correctly

$\sum CRI_b$ = total CRI scores for correct answers

R_s = average CRI for incorrect answers

n_s = number of college students who answered incorrectly

$\sum CRI_s$ = total CRI scores for incorrect answers

2. Determine the fraction of students who answered correctly or incorrectly from the total of all students, using the following equation:

$$f_b = \frac{n_b}{T} \text{ and } f_s = \frac{n_s}{T}$$

with :

f_b = fraction of college students who answered correctly from the total

f_s = fraction of college students who answered incorrectly from the total

n_b = number of college students who answered correctly

n_s = number of college students who answered incorrectly

T = total number of college students.

RESULT AND DISCUSSION

From the data analysis that has been done, the test scores of each college student are obtained. The average test score obtained by college students of the 2019 Sriwijaya University physical education program is known to be quite low, namely 41.25% for 20 question instruments. This instrument has 8 concepts, in this article, will focus on

the concept of the lunar phases period which is located in questions number 5, number 12, and number 17. These concepts have been analyzed to see the form of misconceptions experienced by college students easily and described in the form of CRI and fractions college students in table 3.

TABLE 3. Average CRI of Correct Answers and Wrong Answers and Fractions of Correct Answers and Fractions of Wrong Answers

Number of	Correct Answer		Wrong Answer	
	Average CRI	Fraction	Average CRI	Fraction
5	3.58	0.70	3.78	0.30
12	3.85	0.44	1.83	0.56
17	4.42	0.11	2.75	0.89

From table 2.1 for the concept of the Moon phase period, data number 5 is obtained with the average CRI of students' correct answers of 3.58 and the fraction of students' correct answers of 0.70 and the average CRI of students' incorrect answers being 3.78 and the fraction of students' incorrect answers being 0.30. Next for data number 12, students obtained an average CRI of incorrect answers of 1.83 with a correct answer fraction of 0.44 and an average incorrect answer of 1.83 with an incorrect answer fraction of 0.56. Finally, for question number 17 students get an average CRI score of 4.42 for correct answers and a correct answer fraction of 0.11 and students also get an average CRI score of 2.75 for incorrect answers and an incorrect answer fraction of 0.89. The results of the CRI and college student fractions were then analyzed to obtain a table of college students who understood the concept, 4 as follows:

TABLE 4. CRI categories for number 5

Number of	Good Concept	Lucky Guess	Misconception
5	53.12	23.44	23.44

In table 2.2 for question number 5 students are given a question that reads how often is the new month (new moon) happen. From the data obtained as many as 30 of 64 students who answered the question correctly accompanied by a high average CRI. Other data obtained are 23.44% of students who experience misconceptions, 23.44% of students who do not understand concepts and 53.12% of students who understand concepts. After rounding up the results are obtained in the form of figure 1 as follows:

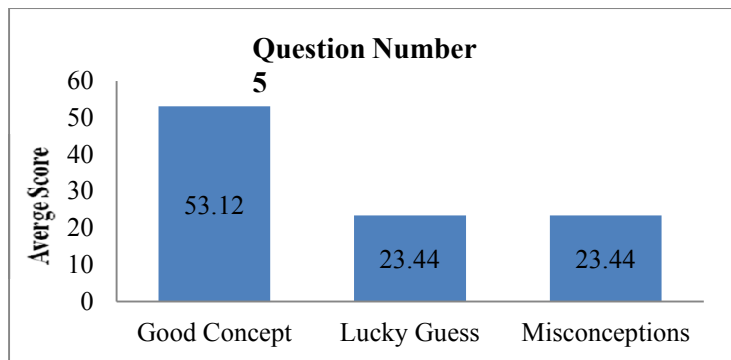


FIGURE 1. Score of CRI Categories for number 5

TABLE 5. CRI categories for number 12

Number of	Good Concept	Lucky Guess	Misconception
12	34.38	35.94	29.68

In question number 12, students ask questions about when the Moon will be in the form of an initial bandage (shown in the form of a picture). From the data obtained, 28 out of 64 students answered correctly with a high CRI average. It was also obtained that an average of 34.38% of students who understood the concept, 35.94% of students who did not understand the concept and 29.68% of students who experienced misconceptions were also obtained. This means that there are still quite a lot of students who experience misconceptions on this question when compared to the previous questions on the same concept. After rounding the results obtained in the form of figure 2.

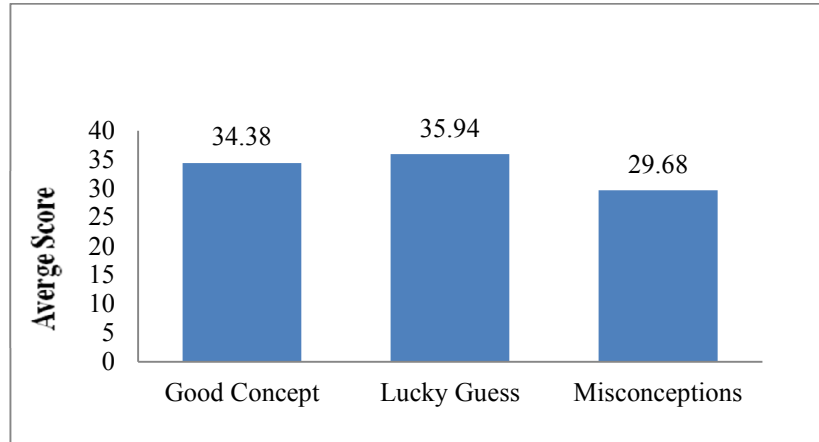


FIGURE 2. Score of CRI Categories for number 12

Table 6. CRI categories for number 17

Number of	Good Concept	Lucky Guess	Misconception
17	10.94	40.62	48.44

In question number 17, students were given a question in the form of 2 pictures of the shape of the Moon phase, students were asked to observe how long the time between the two observations was. From the data obtained, 57 of 64 students answered incorrectly with a high CRI average. It was also obtained that the average of students who understood the concept was 10.94%, those who did not understand the concept were 40.62% of students, and students who experienced misconceptions were as many as 40.62%, 48.44%. The misconception of the concept of the lunar phase period that most students experience lies in this problem. This means that there are still many students who do not understand and even know about the time each moon phase occurs. After rounding the results obtained in the form of figure 3.

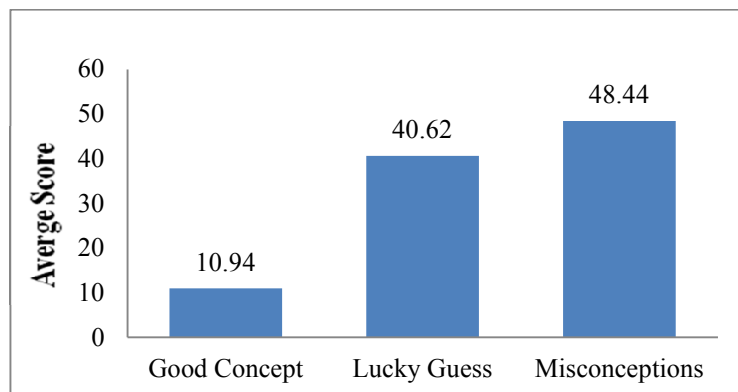


FIGURE 3. The score of CRI Categories for number 17

From the concept understanding test that has been carried out, it was found that quite a number of students had misconceptions about the Lunar phase in the concept of the lunar phase period. As in a study conducted by Wellner [29] at a private university in the Midwest which obtained data that as many as 13 students said the moon's phase was caused by the Moon not being directly in front of the Sun and therefore receiving indirect light, 8 students thought

that the more The farther away from the Sun, the darker the Moon's phase, and only 3 students said the moon's phase cycle was due to the Earth's shadow being involved, and 2 students thought that sunlight bouncing from the Earth to the Moon caused the Moon to glow. A related study was also conducted by Schoon [30] on students from 2 universities who reported as many as 69.5% of students have misconceptions about the cause of the different shapes of the moon phases due to the shadow of the Earth on the Moon. In the results of Kanli [14], it was found that 42% of teachers revealed that the Moon moves towards the Earth's shadow when the Moon phase is formed, and as many as 13% of them say that the Moon moves towards the Sun's shadow. Some students believe that the shape of the Moon cannot be predicted [13]. Students have initial concepts that come from experience and knowledge from the environment which then persists and interferes with student thinking [31]. The intuition that students have towards a concept can cause misconceptions in students [22].

CONCLUSION

The conclusion that can be drawn from the results obtained through research on the misconceptions of prospective physics teacher students about the lunar phase orbital period, it is found that students who experience misconceptions about the lunar phases period are 33.85%, students who do not understand the concept are 33.33% while students who understand the concept of 32.81%. Preconceived notions or conceptual misunderstandings by students greatly affect the risk of misconceptions. In addition, it is also known that other misconceptions experienced by students are as follows: (1). In the concept of the Lunar phase period, many students think that the repetition of the Lunar phase period occurs in less than one month, (2). Many students consider the phase of the new moon happens once a year because students have an understanding that the new moon phase is the same as the phase when a solar eclipse occurs, (3). There are still many students who do not understand the shape of each phase of the Moon so students have difficulty knowing the range of the period of change from one phase to another.

Suggestions that can be given to further researchers are to use other test instruments to be more varied and it is also recommended to use other methods that are more current and accurate so that the research results achieved are more in-depth.

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