Analysis of college students misconceptions in astronomy using four-tier test

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Abstract. This study aims to find out the misconceptions experienced by college students in Astronomy material using four-tier Diagnostic test through the google form. The population of this study were all 5th semester students of the Sriwijaya University Physics Education Study Program. This research is a quantitative descriptive research. Descriptive research here is intended to identify the physics misconceptions experienced by college students in material Astronomy using four-tier diagnostic test. Quantitative research is intended to obtain data from research samples analyzed according to the statistical methods used. This research produces a description of the phenomenon of Astronomical misconceptions that occur. The instrument used is a multiple choice four-tier diagnostic test consisting of 10 questions. Based on the results of research and data analysis showed that overall percentage, college students experienced misconceptions of 57.34%, so that college students' misconceptions were categorized as moderate level misconceptions.

1. Introduction

According to Law No. 23 of 2003 concerning National Education System, Education is a conscious and planned effort to create a learning atmosphere and learning process so that students actively develop their potential to have extraordinary strength, self-control, intelligence, noble character, and the skills they need, society, nation and state. One of the fields of knowledge in the educational process is Natural Sciences (Science), one of the branches of science is physics [1].

To create science education including quality physics learning is influenced by five things, namely understanding concepts, process skills, creativity, developing attitudes, and using concepts in everyday life. In the implementation of the five things above, of course, it cannot be separated from the role of an educator [2,3]. An educator of physics subjects based on Permendiknas No. 16 of 2007 is required to have four competencies, namely pedagogical competence, personality competence, social competence and professional competence. One of the above competencies, namely Professional competence, requires educators to have mastery skills in terms of material, structure, concepts, and scientific mindsets that support the learning process.In the process of learning Physics, understanding concepts are needed for students, in this case the role of educators is needed. Therefore, prospective Physics Educators should understand the concept according to the actual scientific concept. However, sometimes college students as propective of physics subject educators still experience errors in understanding the concept of physics. The source of errors in understanding concepts can come from the wrong initial interpretation, if the wrong interpretation is allowed, there will be misconceptions [4].

Misconception is a concept that is not in accordance with the concept recognized by experts. Misconception refers to a concept that is not in accordance with the scientific understanding or understanding accepted by experts in that field [5,6]. when a person experiences a misconception it means he cannot master the concept as a whole, even mixing between the actual concept with the preconception can cause a lot of physics difficulties. A prospective educator should correct the misconceptions he experiences.To correct these misconceptions, of course college students must know how far the misconceptions they have experienced [7].

Based on the material studied, physics is divided into three states, namely micro physics, visual physics and universe physics. One of the three states of physics is the physics of the universe, which is a physical science that studies the earth and space whose size is so large that it cannot be seen clearly with the naked eye [8]. One of the topics in the physics of the universe is Astronomy. Astronomy is a material that studies celestial bodies.As is well known, this astronomical material is included as one of the fields tested in the OSN (National Student Olympiad)at the school, there are no special subjects taught about astronomy, this makes it difficult for students to explore this astronomical material and even causes students to lack understanding of concepts or experience misconceptions. If improvements are not made by educators and students themselves, misconceptions will spread.Misconceptions can be built through a learning process with the surrounding environment or called constructivism, besides that misconceptions can come from educators, textbooks, teaching methods, contexts, and others [9]. As mentioned earlier, educators are one source of misconceptions, so it is important to identify the misconceptions of prospective educators, namely college students so that the misconceptions experienced by prospective educator students can be corrected [10,11].

In identifying misconceptions, diagnostic tests are needed for college students. Diagnostic tests are tests carried out to find out the weaknesses student, so that from those weaknesses the appropriate treatment [12]. There are many instruments that have been carried out in science education to identify misconceptions such as interviews, open-ended questions, concept maps and multiple choice tests all of which have advantages and disadvantages. The limitations of the previously written instruments encourage researchers to create more effective instruments in identifying misconceptions such as two-tier test, three-tier test and four-tier test [13,14].

Previous research related to the identification of misconceptions about astronomical material uses the CRI (Certainty Of Response Index) instrument as done by Sekar Rachmawati,she identified a misconception in the matter of the solar system.Then there is Taufik Ramlan Ramalis who identified the misconception of IPBA using the CRI (Certainty of Response Index) instrument.Another study related to Astronomy Misconceptions was conducted by Melly Ariska, the instrument used was a two-tier diagnostic test and it was concluded that students' understanding of concepts for each item was still diverse. Overall, the percentage of college students experiencing misconceptions was 15% [15–17].

In its development, the two-tier test instrument has drawbacks because it cannot determine the cause of someone who really experiences misconceptions, in this instrument all incorrect answers are considered misconceptions. Then this weakness is corrected by the presence of a three-tier test instrument which adds a tier of confidence that is placed after the first two levels to ensure one's confidence in answering the questions of the previous two tier [18]. However, this instrument also has limitations, namely when someone fills in at one level feeling unsure of the answer he chooses but inevitably has to choose sure because there is only one level of confidence in the question. For this reason, the present Four-tier test instrument adds two levels of confidence which are located after the question and after the reason. This four-tier diagnostic test instrument is considered to know more about a person's concept understanding[19,20]. Based on the description above, this study will analyze college students' misconceptions about astronomy using a four-tier diagnostic test based on google form.

2. Methods

This type of research is a quantitative descriptive study with a Google Form based Four-Tier Diagnostic Test instrument.The test was carried out on 64 students of the physics education study program. the first tier of this diagnostic test,College Students must choose one of the answers provided, at the second tier college students must choose the tier of confidence in the previous answer.At the third tier, college students must choose one of the reasons that have been provided as a reason for the previous answer. And at the fourth tier, college students must choose the tier of belief for the reasons that have been chosen [21,22]. The four-tier Diagnostic Test can be easier and more detailed in distinguishing between understanding the concepts, not understanding the concepts and misconceptions. The confidence tierl in this diagnostic test is high if the selected scale is 4-6, then the confidence level is low if the selected scale is 1-3.

The results of this four-tier diagnostic test were analyzed with the first step, namely grouping college student answers based on the categories of understanding concepts (UC), not understanding concepts (NUC) and misconceptions (M) according to the criteria in Table 1.

Table1. Interpretation of four-tier diagnostic test results

Category	Tier 1	Tier 2	Tier 3	Tier 4
UC	True	High	True	High
NUC	True	Low	True	Low
	True	High	True	Low
	True	Low	True	High
	True	Low	False	Low
	False	Low	True	Low
	False	Low	False	Low
	True	High	False	Low
	False	Low	True	High
M	True	Low	False	High
	True	High	False	High
	False	High	True	Low
	False	High	True	High
	False	High	False	Low
	False	Low	False	High
	False	High	False	High

The second step is calculates the percentage of answers for each category. To calculate the percentage of college students who understand the concept, do not understand the concept and misconceptions can using the equation as follows[9]:

$$P = \frac{f}{n} x\ 100\% \quad (1)$$

P= percentage value
f= answer frequency
n=total number of college students

The third step is to make a graph of the percentage of misconceptions, and the fourth step is to describe the students' misconceptions for each question and are grouped based on the level of misconceptions according to Table 2 [1,23].

Table 2. Categories for the percentage of misconceptions

Percentage	Category
0 - 30%	Low
31% - 60%	Medium
61% - 100%	High

3. Result and Discussion

This study was attended by 64 students of Semester 5. The diagnostic test given through this google form consists of 10 multiple-choice four-tier questions equipped with options and the level of confidence in the answers and reasons..For the range of confidence levels, it includes only guess (1), very unsure (2), not sure (3), sure (4), very sure (5) and very very sure (6) [9,11].

The results of this diagnostic test are grouped and the number of college students calculated according to the categories Understand the concept (UC), Do not understand the concept (NUC) and Misconception (M), so that the results are as shown in Table 3.

Table 3. The number of college students based on the category of understanding concepts,not understanding concepts and misconceptions

Question Number	Number of college students		
	UC	NUC	M
1	8	12	44
2	0	8	56
3	5	29	30
4	3	16	45
5	8	27	29
6	0	19	45
7	6	30	28
8	10	14	40
9	9	28	27
10	2	39	23
Total	51	222	367
Percentage	7.96%	34.68%	57.34% (Medium)

From the data in table 3, it can be calculated the percentage of each category of college student concept understanding and classifying the level of student misconceptions based on the percentage as shown in Table 4.

Table 4. The results of the analysis of college student concept understanding

Sub Concepts	Percentage (%)			Category (misconceptions)
	UC	NUC	M	
Moon Phase	12.5	18.75	68.75	High
Outer Space Gravity	-	12.50	87.50	High
Relationship beetween planetary mass and body weight	7.81	45.31	46.87	Medium
Center Universe	4.68	25.00	70.31	High
Stars	12.50	42.18	45.31	Medium
Changing Seasons	-	29.68	70.31	High
Sun	9.37	46.87	43.75	Medium
Planets	15.62	21.87	62.50	High
Black Hole	14.06	43.75	42.18	Medium
Influence the mass of stars	3.12	60.93	35.93	Medium

Based on Table 4, it can be seen that in the concept of the moon phase contained in question number 1, the results of college students experiencing misconceptions are 68.75%.In the concept of outer space gravity contained in question number 2, it was found that students experienced misconceptions of 87.5%.In the concept of the relationship between planetary mass and body weight in question number 3, the results showed that college students had misconceptions of 46.87%. on the concept of the center of the universe contained in question number 4, the results of students' misconceptions are 70.31%. In the concept of stars contained in question number 5, it was found that students experienced a misconception of 45.31%.In the concept of changing seasons contained in question number 6, it was found that college students experienced misconceptions of 70.31%.In the concept of the sun contained in question number 7, it was found that college students experienced a misconception of 43.75%. In the concept of planets contained in question number 8, the results showed that college students had misconceptions of 62.5%. In the concept of black holes contained in problem number 9, the results showed that college students had misconceptions of 42.18%. and lastly, on the concept of the influence of the mass of stars contained in question number 10, it was found that college students experienced a misconception of 35.93%.

Based on the results of manual data analysis, it is known that college students experience varying levels of misconceptions in each question, the largest percentage of misconceptions (70.31%) is in items number 4 and 6 and is included in the medium level misconception. The lowest percentage of misconceptions (35.93%) is in question number 10 and is included in the moderate level of misconceptions.The percentage of misconceptions for each question is briefly explained in Figure 1.

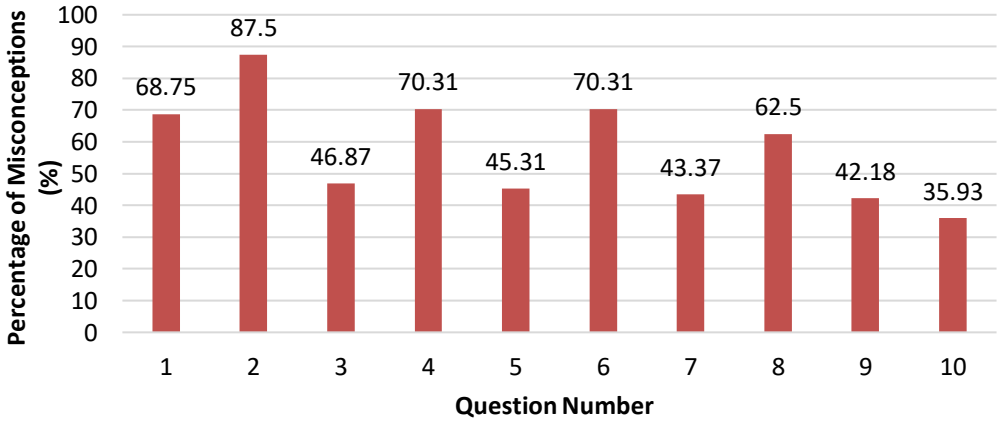

Figure1. Graph of the percentage of college students' misconceptions for each question

Based on the results of the analysis of test data, on the concept of the moon phase, college students experienced a high level of misconception,college Students assume that a solar eclipse occurs when the moon is in its full phase.and college students have a conceptual view that a solar eclipse occurs when the sun, earth and moon form a straight line, it is true that the three form a straight line but the position of the moon in the middle is not the earth.So the correct answer is that a solar eclipse occurs when the moon is in a new phase and a solar eclipse occurs when the moon's position is in the middle between the sun and the earth or the moon can be said to be a bridge between the sun and the earth.

The concept of outer space gravity, college students experience a high level of misconception, college students assume that what causes astronauts to float in spacecraft is because there is no gravitational force in outer space,while in reality the spacecraft has a gravitational force but it is smaller than the earth's gravitational force, this small gravitational force is called the microgravity force. This microgravity force causes astronauts to float in space.

The concept of the relationship between planetary mass and body weight, college students experience a moderate level of misconception, students assume that human weight is related to the

weight of the planet they inhabit, but in reality the weight of the human does not depend on the weight of the planet but depends on the mass of the planet inhabited. Concept of the center of the universe, college students experience a high-level misconception, students assume that the center of the universe is the sun, when in fact the universe has no center, because the big bang theory which is considered the beginning of the formation of the universe does not occur in one place, but occurs in all over the place. Therefore the universe has no center.

The concept of stars, college students experience a moderate level of misconception, there are still students who think that the hottest star is red, in fact the hottest star is blue, and the concept of seasons, college students experience a high level of misconception, students assume that the change of seasons only depends on the revolution of the earth, but in fact the existence of the earth's revolution is to form various types of seasons that differ in each region, while the change of seasons itself depends on the tilt of the axis of rotation. which is the angle of the sun's position with respect to the equator formed during the earth's orbit about the sun.

The concept of the sun, college students experience a moderate level of misconception, in this concept there are still college students who think that solar energy is formed due to a reaction in which two atomic nuclei combine to form one or more small atomic nuclei, but in fact in the sun there is a proton-proton chain reaction which emits enormous energy.The concept of planets, college students experience a high level of misconception, students assume that the planet with the highest temperature is Mercury because it receives a large amount of solar energy, but in fact the planet with the highest temperature is Venus because the planet with the highest temperature is covered by thick clouds coated with carbon dioxide,This carbon dioxide prevents heat from the sun from escaping back into space.

In the concept of a black hole, college students experience a moderate level of misconception, in this concept some students think that the black hole's escape speed has reached the speed of light, but more precisely, a black hole is a giant hole that moves through space that sucks everything in its path. The concept of stellar mass, college students experience a moderate level of misconception, in this concept some students assume that the mass of the star is directly proportional to the age of the star, but the correct concept is that the mass of the star is inversely proportional to the age of the star.

This study shows results that are in line with previous research by Melly Ariska (2021) entitled Overview of the Initial Understanding of Physics Education Students' Concepts on Celestial Objects in Astrophysics Lectures using a two-tier diagnostic test instrument,where in this study it was found that college students experienced misconceptions about astronomical material by 15%.Another studyentitled Understanding the concepts and misconceptions of prospective teacher college students in Kepler law using a two-tier test instrument, where the results of students experiencing misconceptions of 33.82% [6,24]. Another studyentitled Identification of misconceptions about IPBA material in high school using CRI (Certainty Response Index) in an effort to improve the order of giving IPBA material on KTSP, where the results obtained are that there are still many students who have misconceptions and do not know the concepts in the material the IPBA [6,25].

4. Conclusion

Based on the results of the analysis with the four-tier multiple choice diagnostic test, it can be concluded that college students experience the highest misconception of 87.5% regarding the concept of the outer space gravity.Overall, the percentage of college students who understand concepts is 7.96%, college students who do not understand concepts are 34.68% and college students who experience misconceptions are 57.34%, college students' misconceptions on this astronomical material can be categorized as moderate level misconceptions.

Acknowledgement
The author would like to thank the 64 college students of the physics education study program who have become the samples of this research.

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