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Physics Conceptual Understanding of Tadris IPA Biology Students: Insights for Effective Conceptual Teaching Strategies

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Abstract

This study aims to describe the level and characteristics of physics conceptual understanding among prospective science teachers in the Tadris IPA Biology program. The research employed a quantitative descriptive design using a survey method. Participants were 42 first-semester students enrolled in the Basic Physics course. Data were collected through a reasoning-based multiple-choice test consisting of ten valid items with a reliability coefficient of α = 0.623. The tested topics included quantities and measurements, linear and circular motion, temperature and heat, and optics. Descriptive statistical analysis and documentation of students' written reasoning were used to identify conceptual difficulties and misconceptions. The results showed that students' overall conceptual understanding was in the moderate category (3.95). The most frequent misconceptions occurred in the concepts of significant figures, acceleration in circular motion, heat transfer, and lens power in optics. These misconceptions were influenced by students' weak conceptual understanding, reliance on rote memorization and intuitive reasoning, insufficient interactive and repetitive instruction, and the influence of prior learning or everyday experiences. These findings suggest that the learning process in the Tadris IPA Biology program should place greater emphasis on conceptual reinforcement, reasoning-based learning, and multi-representational approaches to improve students' understanding of physics concepts.

Keywords: Conceptual understanding; Physics concepts; Prospective science teachers; Tadris IPA biology

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INTRODUCTION

Physics is one of the branches of science that plays an important role in building the foundation for scientific and logical thinking in students (Rahmasari & Wafa, 2024). In science education at school, physics is an essential component because it explains various natural phenomena through measurable and tested concepts, laws, and principles. Understanding physics concepts is not only necessary for answering academic questions but is also highly relevant in daily life, such as in understanding the motion of objects, energy, force, and other natural phenomena (Fitriani et al., 2021). Therefore, a strong understanding of physics concepts is essential, especially for science teachers and prospective science teachers as the front line in the science education process in schools.

Understanding concepts in physics learning is one of the important roles in shaping critical thinking and problem-solving skills. This is also in accordance with the skills that must be possessed in the 21st century (Arnyana, 2019; Mardhiyah et al., 2021; Maulidia et al., 2023; Sartini & Mulyono, 2022). Therefore, human resources, especially teachers and prospective teachers, must be equipped with a solid understanding of concepts, critical thinking skills, and effective problem-solving skills.

Based on previous research, the understanding of concepts by prospective science and physics teachers is still at a low to moderate level. Some difficulties encountered include reading and interpreting problems in visual forms such as graphs or images, understanding mathematical language in physical concepts, and understanding physical concepts present in everyday life (Nurjumiati et al., 2022; Taqwa, Shodiqin, et al., 2020; Taqwa, Suyudi, et al., 2020). This situation is of particular concern to prospective science teachers because they are not only required to master physics concepts in depth, but also to transform that knowledge to students in a simple and easily understandable way.

Previous studies have consistently reported that the conceptual understanding of physics among prospective science and physics teachers is at a low to moderate level. However, most of these studies have only provided overall test scores without conducting detailed item-level analysis or psychometric validation. In addition, while misconceptions are frequently mentioned, they are rarely documented through students' written reasoning in a systematic way. Furthermore, research specifically targeting prospective Biology Science Education students who are expected to teach integrated science but often face challenges in mastering physics concepts is still rare. The novelty of the present study lies in combining descriptive statistics with item-level analysis and reason-based responses to profile students' conceptual understanding more comprehensively. By focusing on prospective Biology Science Education students in the Basic Physics course, this study not only identifies dominant misconceptions but also provides instructional implications tailored to this unique context.

This research aims to identify the categories of understanding of physics concepts among prospective science teachers in the Biology Science Education program. Students in the Biology Science Education program at Mataram State Islamic University, particularly those taking the Basic Physics course, still require findings related to students' conceptual errors for the purpose of designing effective lectures. This is necessary so that improvements in the learning process can be carried out comprehensively. Improvements in the learning process should not only pertain to the methods used but also to all aspects inherent in the learning process such as methods, strategies, learning media, and evaluations. Therefore, this research is still very much needed to contribute to improvements in the learning process, especially within the scope of Mataram State Islamic University.

METHOD

Research Design

This research was conducted using a non-experimental approach with a quantitative descriptive design aimed at examining students' conceptual understanding and learning difficulties in a basic physics course. The non-experimental design was chosen because the study did not involve treatment or manipulation of variables, but rather focused on describing existing learning conditions and outcomes as they naturally occurred. The quantitative descriptive method allowed for the systematic collection and analysis of numerical data to provide an objective overview of students' conceptual mastery and the types of difficulties they encountered.

Population and Sample

The population of this study consisted of all first-semester students enrolled in the Tadris IPA–Biology study program in the 2024–2025 academic year. This population represented students who were in the early stage of their undergraduate studies and were taking Basic Physics. The sample for this study consists of 42 students. The 42 students consist of 33 females and 9 males. All student participants provided informed consent prior to data collection. Participation was voluntary and confidentiality of responses was guaranteed.

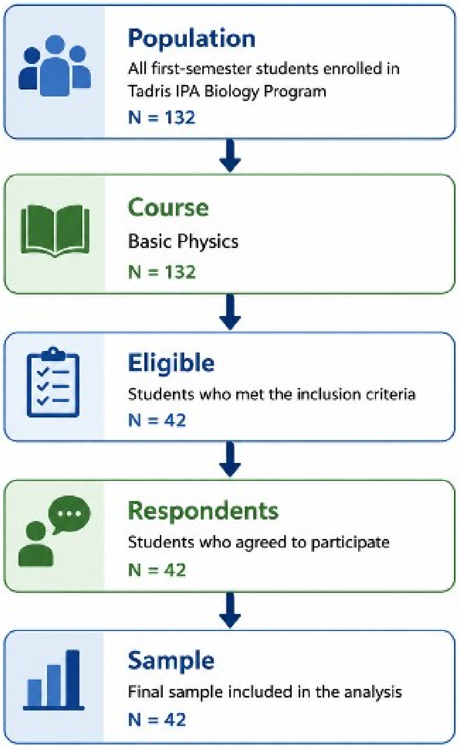


Figure 1. Study flow diagram of participant selection

Instrument and Procedure

The data collection technique in this research uses a survey method by providing reasoned multiple-choice tests. This test aims to determine the understanding of concepts as well as the difficulties faced by students in the basic physics course. The materials tested include quantities and measurements, distance in uniform motion, acceleration in circular motion, temperature and heat, as well as optics.

The instrument consisted of 10 valid reasoned multiple-choice questions. After conducting the validity test, a reliability test was carried out on 10 valid questions, with a reliability coefficient of Cronbach's Alpha (α = 0.623), indicating moderate internal consistency.

Table 1. Summary of Instrument Item Analysis

Items	r_{bis}	Validity Criteria	p	Difficulty Category	r_{pbis}	Difference Category
1	0.499	Valid	0.97	Easy	0.405	High
2	0.499	Valid	0.97	Easy	0.405	High
3	0.499	Valid	0.97	Easy	0.405	High
4	0.547	Valid	0.94	Easy	0.419	High
5	0.499	Valid	0.97	Easy	0.405	High
6	0.433	Valid	0.91	Easy	0.258	Moderate
7	0.502	Valid	0.73	Easy	0.236	Moderate
8	0.428	Valid	0.48	Medium	0.107	Low
9	-0.036	Not valid	0.73	Easy	-0.312	Low
10	0.412	Valid	0.47	Medium	0.090	Low
11	0.028	Not valid	0.67	Medium	-0.272	Low
12	0.446	Valid	0.63	Medium	0.139	Low
13	0.144	Not valid	0.86	Easy	-0.087	Low
14	0.078	Not valid	0.92	Easy	-0.100	Low
15	-0.150	Not valid	0.98	Easy	-0.228	Low

Data Analysis

The data were analyzed using descriptive statistics. Descriptive statistical analysis includes mean, range, maximum value, and minimum value. The purpose of this descriptive statistical analysis is to determine the standard of students' understanding of the concepts. The descriptive statistical measures used in this analysis included the mean, range, maximum value, and minimum value of students' test scores. The mean score was used to represent the average level of students' conceptual understanding, while the range, maximum, and minimum values were utilized to illustrate the distribution and variability of students' performance. These statistical indicators made it possible to determine the overall standard of students' concept comprehension and to identify whether students' understanding tended to be low, moderate, or high. The results of this analysis provided a clear numerical description of students' learning outcomes in relation to the assessed physics concepts. The level of the category of concept understanding is listed in Table 2 adapted from (Azizah et al., 2020).

Table 2. The category of concept understanding

Level of Conceptual Understanding	Category
$\boldsymbol{0 \leq x \leq 3}$	Low
$\boldsymbol{3 \leq x \leq 6}$	Moderate
$\boldsymbol{6 \leq x \leq 10}$	High

The descriptive analysis of students' written reasons was conducted. This analysis focused on student's responses to reasoning-based multiple-choice questions. The purpose of this qualitative descriptive analysis was to identify patterns of reasoning and to reveal specific difficulties faced by students when explaining physics concepts. The study was able to highlight common misconceptions and reasoning errors that contributed to student's incorrect answers.

RESULTS AND DISCUSSION

Research results show that the level of understanding of physics concepts among students of Biology Education (Tadris IPA Biologi) falls into the medium category. The material tested includes quantities and measurements, distance in straight motion, acceleration in circular motion, temperature and heat, as well as optics. The level of understanding of physics concepts was determined by analyzing data using descriptive statistics. Descriptive statistics regarding students' understanding of concepts are presented in Table 3.

Table 3. Descriptive Statistics

Statistics	Scores
Maximum score	7
Minimum score	0
Mean	3.95
Range	0 – 7
Number of Respondents (N)	42

Based on Table 3, it can be seen that students in the Biology Education program have a moderate understanding of concepts. This is evidenced by the average score of students being 3.95, falling within the range $3 < x < 6$. The achievement of this moderate category does not yet represent the equitable understanding of physics concepts overall, as seen from the distribution of student answers on each question, which varies between the number of correct and incorrect answers.

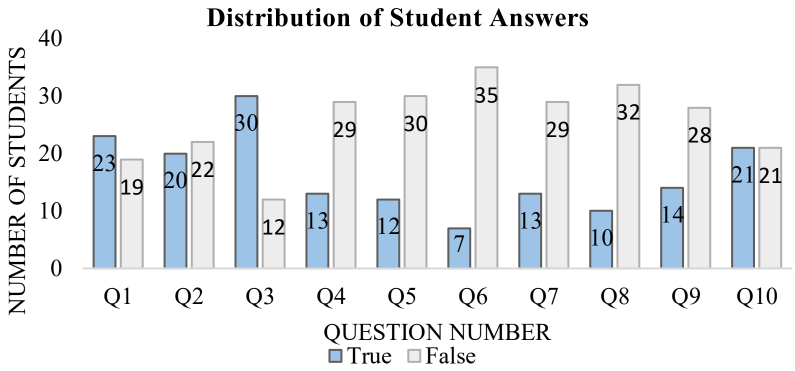


Figure 2. Distribution of Student Answers

Figure 2 is a bar diagram showing the distribution of answers from 42 respondents of Tadris IPA-Biology students. It can be seen that the blue bars represent the distribution of correct answers while the orange bars represent the distribution of incorrect answers. There is a variation in the distribution of students' answers for each question item. These results show variation in students' conceptual understanding across items. The following section discusses possible reasons for these patterns and their implications for physics teaching

The overall moderate level of conceptual understanding is consistent with previous studies reporting low–moderate results among prospective science teachers. This result is in line with Pranata & Seprianto's study on *"Analisis Kesulitan Belajar Fisika Dasar pada Mahasiswa Tadris Biologi"* which also examined challenges faced by biology-major students in basic physics courses(Adelia et al., 2025). Similarly, (Fatimah & Ulfa, 2022) in *Edusaintek* reported that the conceptual understanding of basic physics among biology education students remains low in both contextual and non-contextual assessments.

These prior results reinforce that biology-major students often experience difficulties when dealing with fundamental physics concepts. In our study, this tendency is not only reflected in the overall moderate level of conceptual understanding but also evident in several specific items that produced anomalous response patterns. The following discussion highlights these items (Q3, Q4, Q5, Q6, Q7, Q8 and Q9) and analyzes the misconceptions underlying students' answers.

Question number 3 and question number 4 discuss quantities and measurements by showing opposite results even though the material tested is the same. In question number 3, the number of students who answered correctly was 30 students while 12 students answered incorrectly. In question number 4, the opposite occurred, where the number of students who answered correctly was 13 students while 29 students answered incorrectly.

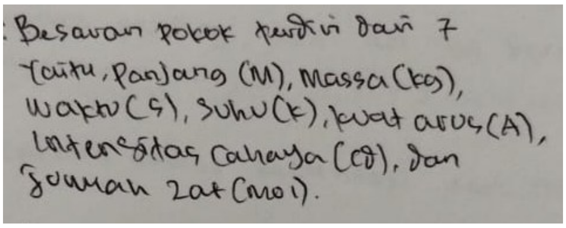
3. Berikut ini adalah beberapa besaran yang ada di fisika, yaitu massa, massa jenis, panjang, luas, suhu, dan kecepatan. Yang termasuk besaran pokok adalah… .
   a. Massa, luas, dan kecepatan
   b. Massa jenis, panjang, dan suhu
   c. Massa, suhu, dan panjang
   d. Panjang, massa jenis, dan kecepatan
   e. Luas, suhu, dan kecepatan

Alasan:

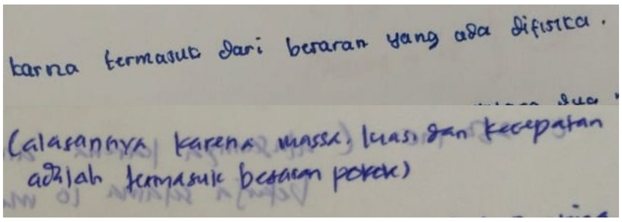
Figure 3. Question Number 3 in the Material of Quantities and Measurement

As has been outlined, most students answered question number 3 correctly. The reasons provided align with the existing concept, which is that the answer choice C is a quantity that falls into the category of fundamental quantities. This shows that students who answered question number 3 correctly have a good understanding of the concept and can distinguish between fundamental and derived quantities. This is also in line with previous research that states that the understanding of concepts on quantities and units is categorized as sufficient(Fitriani et al., 2021; Salassa et al., 2023).

Another fact that cannot be ignored is that there are still students who answered incorrectly on question number 3. After documenting the answers, it was found that the students who answered incorrectly provided reasons that their answer choices were part of the fundamental quantities. This indicates that the students still lack a conceptual understanding of the material on quantities and measurements. Students still cannot distinguish between fundamental and derived quantities. Similar misconceptions have also been reported in earlier studies, where students often mistakenly classified derived quantities such as speed or force as fundamental ones(Novitasari et al., 2021; Saka, Pakiding, et al., 2022). The concept of fundamental quantities in physics is a quantity that has a unit value that has been agreed upon by physics experts, while derived quantities are fundamental quantities that are derived(Nurwahidah, 2022).

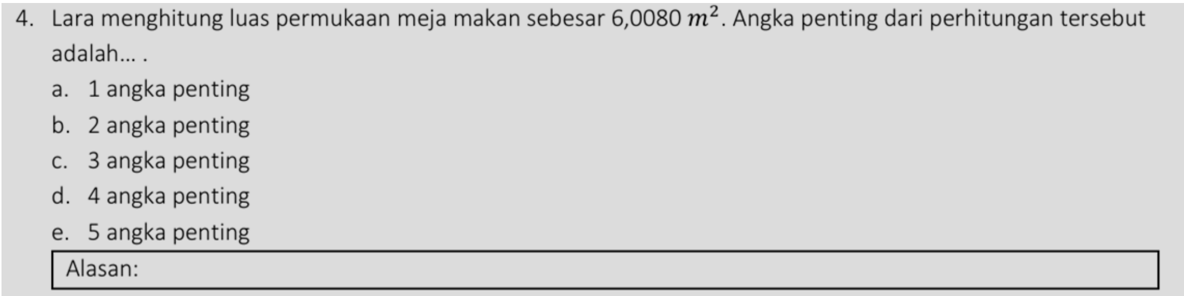


(a)



(b)

Figure 4. Example of Reasons (a) Correct; (b) Incorrect


4. Lara menghitung luas permukaan meja makan sebesar 6,0080 m^2. Angka penting dari perhitungan tersebut adalah… .
   a. 1 angka penting
   b. 2 angka penting
   c. 3 angka penting
   d. 4 angka penting
   e. 5 angka penting

Alasan:

Figure 5. Question Number 4 on the Topic of Quantities and Derivatives

In question number 4, the majority of students answered the question incorrectly, which is 29 students. Generally, the reasons given by students when answering incorrectly are due to conceptual errors. This proves that students still cannot understand the rules of significant figures. The written reasons tend to be partial because they only highlight part of the rules of significant figures and are not accompanied by a deep analysis of the problems presented in question number 4.

Based on Figure 2, in question number 4, there are 13 students who answered the question correctly. After documenting the reasons, it turns out that the explanations provided are still not comprehensive. The reasons given by the students only highlight part of the significant figures rules without conducting a thorough analysis of determining significant figures as a whole.

Based on the explanation of the answer to question number 4, the correct answer does not necessarily indicate a complete understanding of the concept. The rules of significant figures must be explained comprehensively and repeatedly so that students can fully understand the rules of significant figures. These rules are important to understand because they relate to the accuracy of measuring instruments(Sani, 2012). These results are consistent with (Astriyani et al., 2021), who identified that students frequently make errors in significant figures, particularly in counting digits, recognizing zeros, and applying rounding rules. Therefore, explicit and repeated instruction supported by interactive exercises is necessary to strengthen students' understanding of significant figure.

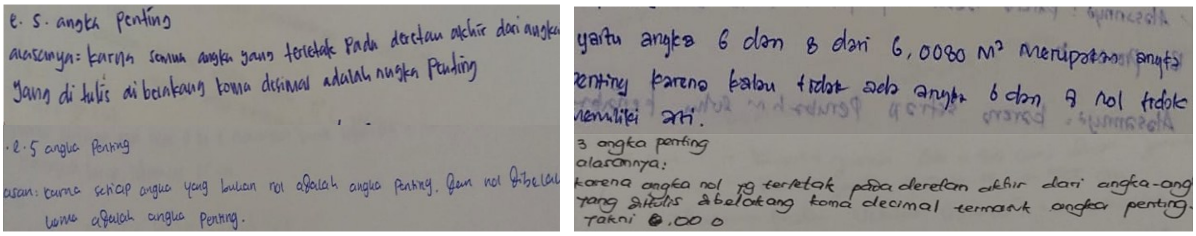
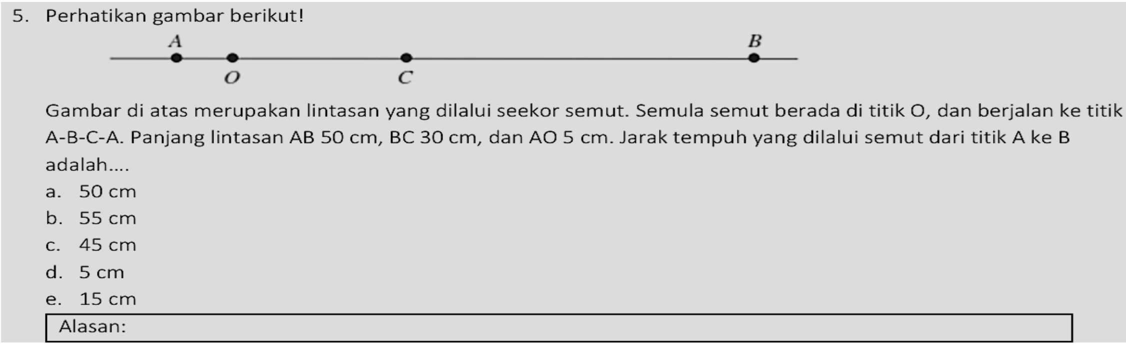


Figure 6. Example Reasons (a) Correct; (b) Incorrect


5. Perhatikan gambar berikut!

Gambar di atas merupakan lintasan yang dilalui seekor semut. Semula semut berada di titik O, dan berjalan ke titik A-B-C-A. Panjang lintasan AB 50 cm, BC 30 cm, dan AO 5 cm. Jarak tempuh yang dilalui semut dari titik A ke B adalah....

a. 50 cm
b. 55 cm
c. 45 cm
d. 5 cm
e. 15 cm

Alasan:

Figure 7. Question number 5 in the Material of Distance and Displacement

In question number 5, there were 30 students who answered incorrectly. This number is greater than the number of students who answered the question correctly. As we already know, the concept of distance is the length of the path traveled by an object(Febriani et al., 2022; Sholehah & Prahastiwi, 2025). In general, students choose option A which represents the length of the path from point A to B. This indicates that students have a conceptual error regarding the concept of distance. As mentioned in the question, an ant travels from O to A to B. The students did not take into account the route from O to A, but instead focused directly on the route from A to B. Previous studies have reported that misconceptions about distance and displacement often occur when students rely on rote memorization rather than deep conceptual understanding (Handayani et al., 2019; Jufriadi & Andinisari, 2020; Magfira & Kamaluddin, 2021).

According to Figure 2, there are 12 students who answered the question correctly. The students have been able to understand the concept of distance where distance is the length of the path taken by an object. Answer choice B is the result of the analysis of the route taken by the ant. The ant walks from point O to A to B. An interesting observation from the documentation of the students' reasons is that their reasoning already refers to good mathematical language (Nurjumiati et al., 2022). Students are now able to communicate the problem into mathematical language to calculate the distance traveled by the ant from point O to point A. Other research has emphasized that the use of multiple representations (graphical, narrative, and mathematical) can improve students' conceptual understanding of straight-line motion (Rasyid et al., 2025; Sutopo et al., 2020). Therefore, encouraging students to express their reasoning through mathematical language is believed to help reduce misconceptions and strengthen their understanding of distance and displacement.

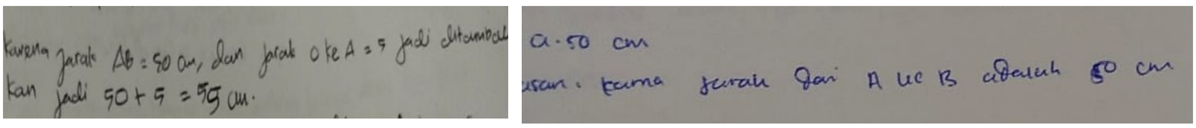
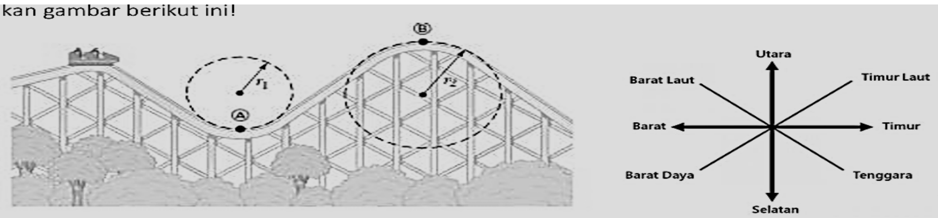


Figure 8. Example Reasons (a) Correct; (b) Incorrect

Perhatikan gambar berikut ini!



Percepatan tangensial dan sentripetal roller coaster pada titik A adalah... .
a. Utara dan Selatan
b. Barat Daya dan Timur Laut
c. Timur dan Utara
d. Timur Laut dan Selatan
e. Barat Laut dan Tenggara

Alasan:

Figure 9. Question Number 6 about Acceleration in Circular Motion

Based on Figure 2, question number 6 is the question with the highest number of students answering incorrectly, which is 35 students. In this question, students were asked to determine the direction of tangential and centripetal acceleration at point A. Generally, students chose answer option D because the path of the roller coaster before and after point A is towards the south and then towards the northeast. This proves that students experienced a conceptual misunderstanding about acceleration in circular motion.

In circular motion, there is tangential and centripetal acceleration to change the velocity and keep the object on its path (Annisa et al., 2019; Taqwa, Shodiqin, et al., 2020). In the problem that occurred, the students believe that the tangential and centripetal accelerations are directed tangentially to the circle (Annisa et al., 2019). The correct concept is that tangential acceleration is tangent to the circle while centripetal acceleration is directed towards the center of the circle (Mutsvangwa, 2020).

Another fact from Figure 2 is that in question number 6, there were 7 students who answered the question correctly. After documenting the reasons, it was found that students still could not or had difficulty in relating the concept of acceleration to circular motion. The reasons provided by the students were limited to merely rewriting the statement of the answer choices without presenting conceptual reasons that demonstrate their understanding of the relationship between centripetal and tangential acceleration in the context of circular motion. Although the answer choice was correct, the students only rewrote the statement of the answer (Fatayah & Purwanto, 2021) proving that students do not yet have a complete understanding of the concepts of tangential acceleration and centripetal acceleration.

C : Timur dan utara
Alasan percepatan tangesial itu dan sentripetal roller coaster pada titik A berarah ke timur ~~dee~~ utara

(a)

Timur laut dan selatan
san: karena arahnya menurun ke (selatan) dan menanjak ke timur laut

(b)

Figure 10. Example Reasons (a) Correct; (b) Incorrect

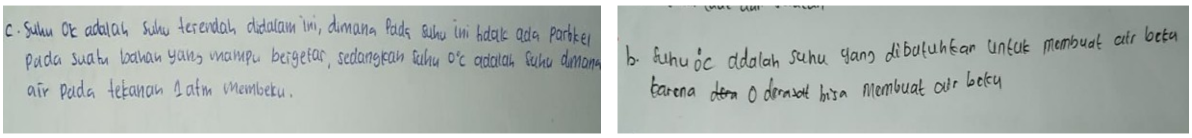
Makna dari benda memiliki suhu 0 K atau benda memiliki suhu 0^0C adalah... .
a. Suhu 0 K adalah suhu yang dibutuhkan untuk membuat air membeku
b. Suhu 0^0C adalah suhu yang dibutuhkan untuk membuat air membeku
c. Suhu 0 K adalah suhu terendah dialam ini, dimana pada suhu ini tidak ada partikel pada suatu bahan yang mampu bergetar, sedangkan suhu 0^0 C adalah suhu dimana air pada tekanan 1 atm membeku
d. Suhu 0 K adalah suhu dimana air pada tekanan 1 atm membeku dan suhu 0^0 C adalah suhu terendah dialam ini, dimana pada suhu ini tidak ada partikel pada suatu bahan yang mampu untuk bergetar
e. Suhu 0 K dan suhu 0^0 C pada benda merupakan nilai yang sama jika diukur dengan thermometer.

Figure 11. Question Number 7 About Temperature and Heat

The results from question number 7 show that there are 29 students who answered incorrectly. Question number 7 is about meaning of temperature 0 K and 0 ºC. In question number 7, students are asked to interpret the temperatures 0 K and 0 °C. After documenting the answers, the reasons provided by the students are incorrect in interpreting the temperatures 0 K and 0 °C. The students' answers indicate a fundamental misunderstanding about the difference between absolute temperature (0 K) and the freezing point of water (0 °C at 1 atm). Most students consider the two temperatures to be the same or even assume that 0 K is the temperature at which water freezes. 0 K is the lowest temperature, at which the particles of a substance no longer have kinetic energy to vibrate, while 0 °C is the freezing point of water under standard pressure conditions.

This result is consistent with the study by Alwan (2011), which revealed that many students believe there is no limit to the lowest temperature, as well as with Kácovský (2015), who reported that students assumed water cannot exist at 0 °C (Alwan, 2011; Kacovsky, 2015). Therefore, the misconceptions experienced by students in this study can be categorized as an inability to distinguish between the absolute temperature scale (Kelvin) and the relative scale (Celsius) and a misunderstanding of how temperature concepts are connected to physical phenomena.

Although 13 students chose the correct answer on question number 7, the analysis of the answer sheets shows that their understanding is still shallow. This is evident from the tendency of students to merely copy the selected answer without providing further explanation or linking it to the concepts of temperature and heat. This condition indicates that the correct answers given are not always based on strong conceptual understanding, but rather on guessing or memorization alone, reflecting the persistence of misconceptions in distinguishing and applying the concepts of temperature and heat. Similar findings were also reported by Maison, Safitri, & Wardana (2020), who emphasized that although students sometimes choose the correct answer, the explanations or reasons provided are often inaccurate, thus still indicating the presence of misconceptions (Maison et al., 2020). This is also supported by Ni'mah, Kusairi, & Supriana (2019), who found that tiered diagnostic instruments could reveal that correct answers without appropriate conceptual reasoning still indicate weak student understanding of the concepts of temperature and heat (Ni'mah et al., 2019).



(a) (b)

Figure 12. Example Reasons (a) Correct; (b) Incorrect

Number 8 required students to identify the mode of heat transfer that occurs through radiation. The findings revealed that 32 students answered incorrectly, with a predominant tendency to select the option stating that all items represent radiation. This pattern suggests that many students were unable to differentiate between radiation, conduction, and convection. Instead, they tended to associate the sensation of warmth or the presence of a heat source exclusively with radiation, without considering the physical conditions involved (direct contact, fluid flow, or the presence of a medium). Such misconceptions are consistent with previous studies, which reported that students often rely on everyday experiences and surface-level reasoning, resulting in correct responses that are not supported by sound conceptual understanding (Alwan, 2011; Ekawati Haryono et al., 2019; Suliyanah et al., 2018).

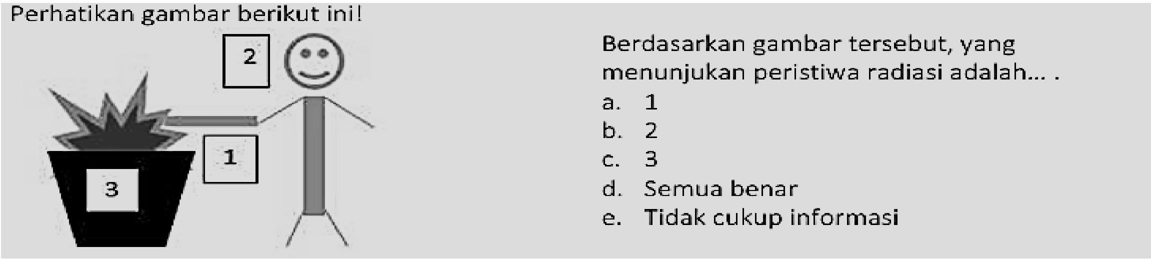
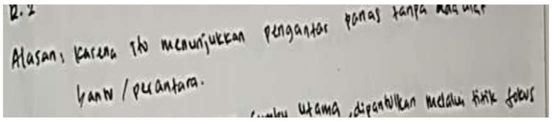
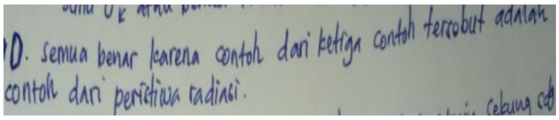


Figure 13. Question Number 8 About Temperature and Heat



(a)



(b)

Figure 14. Example Reasons (a) Correct; (b) Incorrect

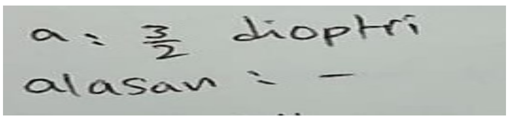
Pada saat membaca, jarak terdekat yang dapat dilihat seorang penderita rabun dekat adalah 40 cm. kekuatan lensa kacamata yang diperlukan adalah....

a. $\frac{3}{2}$ dioptri
b. $\frac{3}{4}$ dioptri
c. $\frac{2}{3}$ dioptri
d. $\frac{1}{4}$ dioptri
e. $\frac{4}{3}$ dioptri

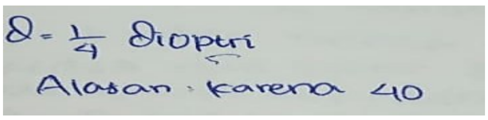
Figure 15. Question Number 9 About Optics

Question number 9 is an optics question that requires students to determine the lens power of eyeglasses for a person with hypermetropia (farsightedness). Students must understand the basic concept of image formation in a convex lens and the relationship between object distance, image distance, and focal length. This question also measures students' ability to apply the concept of lens power to analyze and solve vision problems related to farsightedness.

In question number 9, 14 students answered correctly while 28 students answered incorrectly. This finding indicates that most students have not yet mastered the concept of optics, particularly in determining the lens power for cases of farsightedness. Based on the documentation of students' answers, it was also observed that both those who answered correctly and incorrectly merely rewrote their responses without providing reasoning consistent with the concept of lens power. The high number of incorrect answers suggests the presence of misconceptions regarding the relationship between object distance, image distance, and lens power in the context of image formation by a convex lens. This result is consistent with the study by Jones and Zollman (2014), which revealed that many students hold misconceptions about image formation due to intuitive reasoning that contradicts scientific principles (Jones & Zollman, 2014). Similarly, Handayani and Arifin (2021) found that students still struggle to determine the focal length and direction of image formation in convex lenses (S. L. Handayani & Arifin, 2021). Furthermore, Pasaribu (2023) reported that prospective physics teachers often make errors in applying the mathematical relationship among object distance, image distance, and focal length when calculating lens power(Pasaribu et al., 2023). Therefore, the findings of this study reinforce previous research indicating that misconceptions in optics remain prevalent and require greater attention in the teaching and learning of lens and vision concepts.



(a)



(b)

Figure 16. Example Reasons (a) Correct; (b) Incorrect

Based on the data and the discussion of the seven questions, an unusual distribution pattern was observed in students' answers and the documentation of their reasoning. Students still struggle to analyze problems holistically and experience difficulty connecting their analytical results with underlying physics concepts. In addition, many students are unable to effectively use mathematical representations, indicating the need for further practice. Visual aspects, such as interpreting images and graphs, also require additional training.

In essence, conceptual errors are a common occurrence among students and are not limited to the learning process itself. These errors persist because students carry misconceptions from previous educational levels and fail to reconstruct or activate scientific concepts comprehensively (Zainuddin et al., 2019). Previous research has also identified several factors influencing conceptual errors, including textbooks, learning context and methods, teachers, and the students themselves (Febriani et al., 2022).

The results showing that students' conceptual understanding remains at a moderate level indicate the need for improvement in the physics learning process, particularly in the Tadris IPA Biology program, to enhance conceptual comprehension. Furthermore, improving the learning process also contributes to the development of students' critical thinking skills, which are among the essential competencies in the 21st century (Arnyana, 2019; Mardhiyah et al., 2021; Maulidia et al., 2023; Sartini & Mulyono, 2022). Such improvements can be achieved through meaningful and conceptually oriented learning, for instance, by developing instructional media that align with students' characteristics and learning needs (Hayati et al., 2015; Khoirin, 2023; Prahastiwi & Zain, 2023; Siti et al., 2020; Yulianci et al., 2017; Yusman et al., 2023).

CONCLUSION

The results of this study show that the overall level of students' conceptual understanding in the Basic Physics course of the Tadris IPA Biology program is in the moderate category with an average score of 3.95. This indicates that prospective science teachers still face difficulties in applying and connecting physics concepts to reasoning-based problem solving. The most frequent misconceptions were found in the concepts of significant figures, acceleration in circular motion, heat transfer, and lens power in optics. These misconceptions are primarily influenced by weak conceptual understanding, reliance on rote memorization and intuitive reasoning, limited interactive and repetitive instruction, and the influence of prior learning or everyday experiences. Therefore, it is necessary to strengthen the learning process through conceptual reinforcement, reasoning-based learning, and multi-representational approaches to improve students' mastery and integration of physics concepts.

RECOMMENDATION

Based on the findings of this study, several recommendations can be proposed to improve students' conceptual understanding of physics. First, lecturers should emphasize conceptual and reasoning-based learning approaches, enabling students to connect physical phenomena with their underlying principles rather than relying solely on memorization. Second, the use of multi-representational teaching strategies including visual, mathematical, and verbal representations, should be integrated to help students link abstract concepts with real-world contexts. Third, the development of interactive learning media aligned with students' characteristics and learning needs is essential to facilitate meaningful learning experiences. Fourth, implementing diagnostic assessments at the beginning and end of instruction can help identify students' misconceptions early and track conceptual growth. Finally, further research is recommended to explore instructional models and interventions that effectively reduce misconceptions and strengthen conceptual understanding among prospective science teachers in the Tadris IPA Biology program.

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AUTHOR CONTRIBUTIONS STATEMENT

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Rima Buana Prahastiwi	✓	✓			✓	✓	✓	✓		✓			✓	✓
Najah Sholehah			✓	✓				✓	✓		✓	✓		✓

CONFLICT OF INTEREST STATEMENT
Authors state no conflict of interest.

DATA AVAILABILITY
The data that support the findings of this study are available from the corresponding author upon reasonable request.

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