JoTaLP: Journal of Teaching and Learning Physics 7, 1 (2022): 42-53
Website: http://journal.uinsgd.ac.id/index.php/jtlp/index
ISSN 2580-3107 **(online) ISSN** 2528-5505 **(print)**

[Research Article]

IDENTIFICATION OF PHYSICAL MISCONCEPTIONS AND THEIR CAUSES USING FIVE-TIER KINEMATICS TEST (FTKT) ON HIGH SCHOOL STUDENTS

Nurul Naasyithotul Jannah[1], Novia Anditya[2], Winny Liliawati[1] and Muslim[1]

[1]Department of Physics Education, Faculty of Mathematics and Natural Sciences Education, Universitas Pendidikan Indonesia, Bandung, Indonesia
[2]Teacher College, Columbia University, USA
E-mail: nurul@student.upi.edu

DOI: https://doi.org/10.15575/jotalp.v7i1.11282
Received: 1 February 2021 ; Accepted: 10 February 2022 ; Published: 28 February 2022

ABSTRACT

This study aims to identify misconceptions in physics concepts and find out the causes of misconceptions. This type of research is descriptive quantitative research. The research instrument used a five-tier diagnostic test. Determination of samples taken by purposive sampling technique. This research was conducted on 120 students with 55 male and 65 female students from senior high schools in West Bandung Regency and three high schools in Majalengka Regency. Based on the validation results, it shows that the 12 items are categorized as valid and the reliability value is 0.93 which is included in the very good category. The misconceptions identified with the largest percentage are in the concepts of distance, position, and displacement of 49.17%.

Keywords: Misconceptions, Five-Tier Kinematics Test (FTKT), physics education

How to cite: Jannah N. N., Liliawati, W. & Muslim (2022). Identification of physical misconceptions and their causes using five-tier kinematics test (ftkt) on high school students, *Journal of Teaching and Learning Physics* ***7*** (1), 42-53. DOI: https://doi.org/10.15575/jotalp.v7i1.11282

1. INTRODUCTION

Physics is a branch of science that tries to explain how nature works using the mathematical language of Harefa (2019). It involves the study of universal laws and behavior and the relationships among various physical phenomena. Improving the ability and skills of learning physics requires ways and techniques that are carried out by the teacher. Teachers must have stages in planning learning activities so that they can run well. The teacher is an important role in an education. Teachers who regulate and condition learning activities so that teachers must have methods and ways to facilitate the course of learning so that students are able to master and understand the material.

Based on previous literature studies, it is often stated that many students have errors in physics concepts. The fallacy of this physical concept can be called a misconception. Silviani, et al (2020) stated that misconceptions are errors in understanding the concept of learning material that can cause a mismatch between the concepts owned by individuals and scientific concepts or concepts owned by scientists. According to Inggit, et al. (2021) and Soeharto (2019) misconceptions are defined as misunderstandings of certain concepts experienced by a person as a result of previously constructed concepts that are not in accordance with the scientific understanding of experts in that field. Misconceptions can also be in the form of erroneous initial concepts and errors in connecting concepts. This was also added by Mulyani, et al (2015) who support Silviani opinion that this misconception can also occur due to misinterpreting processes and even phenomena that are related to one another that are not immediately corrected and are different from scientific concepts. Students are not able to understand correctly the concepts of physics so that the interpretation issued is wrong. This interpretation is often also contradictory to private knowledge or scientific concepts with experts.

Based on the results of the research that has been described by the experts above, there is one way to find out misconceptions in students is with a diagnostic test. Suprapto (2020) states that the use of diagnostic tests at the beginning and at the end of learning can help teachers find students' misconceptions about the material being studied. So, based on this opinion, the test is very important at the end of the lesson. The teacher in this case must provide a diagnostic test to determine the level of students' ability to understand physics concepts. Through this activity the teacher becomes aware of the misconceptions experienced by students. Students who misunderstand physics learning material will be seen when doing the diagnostic test. This activity is also one of the supervision and control activities carried out by teachers to maintain good understanding and interpretation of the context and concepts of physics learning so that mistakes do not occur. Teacher control through this diagnostic test can also minimize the number of students who are wrong in capturing the lessons that have been conveyed by the teacher.

This right diagnostic test can provide accurate and valid results for the misconceptions that occur in students based on the mistakes made by these students. In this diagnostic test, students are not only paid attention and supervised regarding the understanding of the physics concepts that have been studied, but through this test the teacher must also understand and know the behavior of students in their thinking abilities. Teachers must be able to know the flow of thought experienced by students in understanding these physics concepts.

Besides, the teacher should also look at the answers that have been filled in by students to find out the extent of the students' understanding abilities. So, through the level of understanding that is known, the teacher can measure the ability of his students. The teacher continues to provide supervision and improvement of student answers through the test even though the answer is wrong. In this diagnostic test, there are several tests,

namely two-tier, three-tier, and four-tier diagnostic tests.

On The development of this second type of diagnostic also still has shortcomings that are used to measure students' misconceptions. In this second type, identification is still obtained in the first choice and the second choice still does not provide a differentiator for the misconceptions experienced by students. This can give students a lack of knowledge as well as a reduction in the score given. This will also cause the level of misconception to be higher because the two answers do not provide a difference.

Based on these problems, it was further developed into a diagnostic test that has three levels of answers to minimize the occurrence of higher misconceptions in students. In this type of diagnostic level three will be given a level of confidence in the reasons. This level of confidence is able to accurately and validly assess its own performance. This level of confidence can also be used as an estimate of yourself. This type of third-level diagnostic test when combined with a questionnaire can provide a level of misconception experienced by students. Through the test will find out the level of misconceptions and the causes of misconceptions in these students.

Based on previous research, it was found that students' misconceptions regarding physics learning often occur on the subject of motion, heat temperature, light, dynamic electricity and the concept of straight motion. The concept of straight motion is a physics material for class X semester 1. In this material, experts have revealed the misconceptions experienced by the acceleration of gravity. This can be proven through the free fall test which is carried out by dropping objects that have a heavy mass and objects that have a light mass.

As a result, objects that have a heavier mass have a faster falling speed than objects that have a lighter mass. Furthermore, in relation to the concepts of distance and displacement, students think that these two concepts are the same. Another example is the findings of Khoiri (2018) and Nurdiansyah (2018) which states that 7, 2% or nine of the thirty concepts of linear motion kinematics material written in the handbook have the potential for misconceptions.

Batlolona (2018) and Gunawan (2019) stated that grade 1 students at a public high school in Bandung experienced a kinematics misconception of straight motion above 10%. Based on the results of initial observations made by researchers. The researcher observed the students of class X IPA 2 with a total of 34 students in the 2013/2014 school year. In the results of this initial observation, the researchers found that students had misconceptions with a percentage of 20%. There are so many students who have misconceptions, especially in learning physics. The misconceptions experienced by students in learning physics are related to linear motion kinematics material. Batlolona (2018) stated that grade 1 students at a public high school in Bandung experienced a kinematics misconception of straight motion above 10%. Based on the results of initial observations made by researchers. The researcher observed the students of class X IPA 2 with a total of 34 students in the 2013/2014 school year. In the results of this initial observation, the researchers found that students had misconceptions with a percentage of 20%. There are so many students who have misconceptions, especially in learning physics.

The misconceptions experienced by students in learning physics are related to linear motion kinematics material. Batlolona (2018) stated that grade 1 students at a public high school in Bandung experienced a kinematics misconception of straight motion above 10%. Based on the results of initial observations made by researchers. The researcher observed the students of class X IPA 2 with a total of 34 students in the 2013/2014 school year. In the results of this initial observation, the researchers found that students had misconceptions with a percentage of 20%. There are so many students

who have misconceptions, especially in learning physics. The misconceptions experienced by students in learning physics are related to linear motion kinematics material. The researcher observed the students of class X IPA 2 with a total of 34 students in the 2013/2014 school year. In the results of this initial observation, the researchers found that students had misconceptions with a percentage of 20%. There are so many students who have misconceptions, especially in learning physics.

The misconceptions experienced by students in learning physics are related to linear motion kinematics material. The researcher observed the students of class X IPA 2 with a total of 34 students in the 2013/2014 school year. In the results of this initial observation, the researchers found that students had misconceptions with a percentage of 20%. There are so many students who have misconceptions, especially in learning physics. The misconceptions experienced by students in learning physics are related to linear motion kinematics material.

The novelty of this study is a five tier diagnostic test which can detect misconception more correctly. In this study, the aim is to find out the profile of misconceptions that can be revealed through a five-tier diagnostic test on the kinematics material of straight motion and the causes of misconceptions experienced by students.

2. METHOD

This research will use quantitative research with exploratory descriptive type. This study will use a non-experimental approach, namely research by not giving prior treatment to the subject so that the condition of the subject at the time of the study is in its natural state (Wiersma & Jurs, 2009).

The participants of this study were senior high school students in the odd semester based on the high school physics syllabus. One school is located in the Bandung Regency area and the other three schools are located in the Majalengka Regency area. Then the sample of this research is in Table 1.

Table 1. Research Sample

No	School name	Number of Samples	Gender	
			L	P
1.	KBB High School	38	15	23
2.	SMA A KM	28	13	15
3.	SMA B KM	32	17	15
4.	SMA C KM	22	10	12
	Total	120	55	65

To identify misconceptions and their causes in high school students, this study uses a series of Five-Tier Kinematics Test (FTKT) or a five-level diagnostic test regarding linear motion kinematics material on google-form. The format of the test is multiple choice for tier-1 and tier-3, confidence level for tier-2 and tier-4, and a questionnaire questionnaire for tier-5.

The instrument was tested for content validity and the construct was analyzed using the Content Validity Ratio (CVR) approach. CVR is a content validation approach to determine the suitability of question items with components measured based on expert judgment (Lawshe, 1975; Baghestani, et. al. 2019; Shrotryia, 2019). The answers to the questions used the CVR method. After getting a score, then the score is processed using the CVR calculation method. The instrument construct validation involved a Physics Education University lecturer and a high school physics teacher, totaling three lecturers and two high school physics teachers. The instrument validity test in this study used the following criteria: (a) the suitability of the items with the conceptions/misconceptions revealed, (b) the suitability of the concepts in the items with the concepts proposed by the experts, (c) the use of language in accordance with the rules of the Indonesian language and (d) the suitability of the item construction with the rules for writing multiple choice questions. Based on the results of the validity of this instrument, it was found that the minimum CVR value was 0.736.

However, after being tested, five experts found that at numbers 1, 6, 8, 10, 12, 13, 19 and 20 the average value did not reach 0.736. This means that from 20 questions there are 8 questions that are invalid so that they cannot be used as research instruments to test. So, the questions that will be asked are 12 questions.

The analysis used to test the reliability of the instrument in this study was using Cronbach's Alpha. By doing the instrument reliability test, it is known how much consistency the question is if it is done by different people, different places, and different times.

Through the results of the reliability test, the person showed poor results. This is evidenced by the results of r = 0.59.

	TOTAL SCORE	COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	12.0	20.0	-3.11	1.24				
SEM	.3	.0	.48	.06				
P.SD	1.6	.0	2.61	.34				
S.SD	1.7	.0	2.65	.35				
MAX.	17.0	20.0	4.51	2.10				
MIN.	9.0	20.0	-8.60	.91				
REAL RMSE	1.43	TRUE SD	2.18	SEPARATION	1.52	Person RELIABILITY	.70	
MODEL RMSE	1.29	TRUE SD	2.27	SEPARATION	1.76	Person RELIABILITY	.76	
S.E. OF Person MEAN = .48								

Person RAW SCORE-TO-MEASURE CORRELATION = .99
CRONBACH ALPHA (KR-20) Person RAW SCORE "TEST" RELIABILITY = .59 SEM = 1.05

Figure 1 Person Tier Reliability Answer

However, the item reliability test showed the result of 0.93. This proves that the FTKT questions can give good results if tested on students.

	TOTAL SCORE	COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	18.0	30.0	-3.76	1.43				
SEM	2.8	.0	1.33	.13				
P.SD	12.8	.0	5.78	.55				
S.SD	12.7	.0	5.93	.56				
MAX.	30.0	30.0	5.85	1.93				
MIN.	.0	30.0	-9.00	.45				
REAL RMSE	1.55	TRUE SD	5.57	SEPARATION	3.59	Item RELIABILITY	.93	
MODEL RMSE	1.53	TRUE SD	5.58	SEPARATION	3.64	Item RELIABILITY	.93	
S.E. OF Item MEAN = 1.33								

Item RAW SCORE-TO-MEASURE CORRELATION = -.99
Global statistics: please see Table 44.
UMEAN=.0000 USCALE=1.0000

Figure 2 Answer Tier Item Reliability

Through the results of the reliability of the person tier, the reason is bad with a value of r = 0.38.

	TOTAL SCORE	COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	11.3	20.0	1.54	1.27				
SEM	.2	.0	.38	.06				
P.SD	1.3	.0	2.03	.31				
S.SD	1.3	.0	2.06	.32				
MAX.	14.0	20.0	5.26	1.89				
MIN.	8.0	20.0	-4.31	1.02				
REAL RMSE	1.53	TRUE SD	1.33	SEPARATION	.87	Person RELIABILITY	.43	
MODEL RMSE	1.31	TRUE SD	1.55	SEPARATION	1.18	Person RELIABILITY	.58	
S.E. OF Person MEAN = .38								

Person RAW SCORE-TO-MEASURE CORRELATION = .99
CRONBACH ALPHA (KR-20) Person RAW SCORE "TEST" RELIABILITY = .38 SEM = 1.00

Figure 3 Person Tier Reliability Reason

Meanwhile, the reliability of the reason tier item showed good results with a value of r = 0.91. This shows that the questions are included in the quality and good category.

	TOTAL SCORE	COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	16.9	30.0	.14	1.49				
SEM	2.9	.0	1.24	.13				
P.SD	13.2	.0	5.39	.58				
S.SD	13.2	.0	5.53	.59				
MAX.	30.0	30.0	7.00	1.91				
MIN.	.0	30.0	-5.59	.45				
REAL RMSE	1.61	TRUE SD	5.15	SEPARATION	3.19	Item RELIABILITY	.91	
MODEL RMSE	1.60	TRUE SD	5.15	SEPARATION	3.22	Item RELIABILITY	.91	
S.E. OF Item MEAN = 1.24								

Item RAW SCORE-TO-MEASURE CORRELATION = -1.00
Global statistics: please see Table 44.
UMEAN=.0000 USCALE=1.0000

Figure 4. Item Reliability Tier Reason

Figure 5 and Figure 6 show that the first and second tiers have poor results with a value of r = 58. This shows that the first and second tiers do not give the same results when tested again.

SUMMARY OF 30 MEASURED Person

	TOTAL SCORE	COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	13.9	25.0	-1.66	1.13	.96	-.07	.40	-.32
SEM	.3	.0	.44	.04	.15	.18	.10	.12
P.SD	1.7	.0	2.35	.22	.82	.95	.52	.64
S.SD	1.7	.0	2.39	.23	.83	.96	.53	.65
MAX.	19.0	25.0	5.50	1.91	4.62	2.55	2.99	1.88
MIN.	11.0	25.0	-5.53	.91	.04	-1.23	.02	-1.81
REAL RMSE	1.27	TRUE SD	1.97	SEPARATION	1.55	Person RELIABILITY	.70	
MODEL RMSE	1.15	TRUE SD	2.05	SEPARATION	1.78	Person RELIABILITY	.76	
S.E. OF Person MEAN = .44								

Person RAW SCORE-TO-MEASURE CORRELATION = .99
CRONBACH ALPHA (KR-20) Person RAW SCORE "TEST" RELIABILITY = .58 SEM = 1.09

Figure 5. Person Tier Reliability Answer and Reason

Meanwhile, item reliability shows the results of r = 0.93 which means that it can give the same good results when tested again on students.

	TOTAL SCORE	COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	16.7	30.0	-1.68	1.44				
SEM	2.7	.0	1.23	.11				
P.SD	13.3	.0	6.03	.54				
S.SD	13.6	.0	6.16	.55				
MAX.	30.0	30.0	6.83	1.91				
MIN.	.0	30.0	-7.71	.44				
REAL RMSE	1.56	TRUE SD	5.83	SEPARATION	3.74	Item	RELIABILITY	.93
MODEL RMSE	1.54	TRUE SD	5.83	SEPARATION	3.79	Item	RELIABILITY	.93
S.E. OF Item MEAN = 1.23								

Item RAW SCORE-TO-MEASURE CORRELATION = -.99
Global statistics: please see Table 44.
UMEAN=.0000 USCALE=1.0000

Figure 6. Answer Tier Item Reliability and Reason

Data collection is done through a survey method in several schools that have been determined. To make it easier, students are asked to fill in several questions that have been tested for validity and reliability, then the data is processed. To be more convincing, interviews were also conducted with several students to ensure that there were misconceptions or not. So that it can be said that the method used in collecting data is a survey because it provides questions for research on reports of beliefs/beliefs or self-behavior by taking samples from one population and using questionnaires as the main data collection tool.

The data processed from the test was analyzed using a scoring technique for each five-tier test item which was adopted from the scoring technique carried out by Celeon & Subramaniam (2010b), namely if the answer was at the first level (first tier) and the reasons chosen (three tier) is correct, then it is given a score of 1 and other than that type, it is given a score of 0 for each level one, two, three, and four. Meanwhile, for the source questionnaire, students are allowed to choose more than one, but they must be ranked from the most dominant.

The misconceptions experienced by students can be identified through the value of the confidence discrimination quotient (CDQ) obtained. If the CDQ obtained is negative, then there is a misconception at the level of the question.

Caleon (2010b), Shafwatul (2019) and Widiyatmoko (2018) state that misconceptions are stated as significant misconceptions if the misconception is experienced by at least 10% of the sample. Misconceptions experienced by 10% can be said to be absolute misconceptions. The CDQ value obtained is what will be a benchmark to find out whether there are misconceptions in the item. The CDQ scores in this test are divided into three, namely CDQ1 for first-level questions, CDQ3 for third-level questions and CDQ13 for a combination of first-level and third-level questions. The value of this CDQ is obtained through data on the level of student confidence at each level of the question. In obtaining this CDQ value, the standard deviation (s) value for the confidence level of all students is also required, so that the standard deviation values for calculating CDQ1, CDQ3, and CDQ13 will be different.

If the CDQ value obtained is negative, it can be seen that the confidence level of students who answered correctly was lower than that of students who answered incorrectly, unconsciously they experienced misconceptions. Furthermore, if there are misconceptions that occur in students, the significance of these misconceptions must be confirmed by looking at the percentage of participants. Misconceptions will be said to be significant if experienced by at least 10% of the participants (Caleon, 2010).

On fifth level, analyzed by giving a score of 1 to 4 depending on the level or percentage of students in using the source as a reference in answering questions. So, based on this analysis, it can be seen the causes of students' misconceptions. The source of student understanding of the concept with the largest percentage indicates that the source has the greatest influence on the formation of student understanding. Therefore, to identify the causes of students' misconceptions, it can be done by analyzing the sources most used by students as a reference in answering questions on the test.

3. RESULT AND DISCUSSION

The results and discussion in this study include the identification of misconceptions and their causes using the five-tier kinematics test

3.1 Misconceptions of Straight Motion Kinematics

The results of the five-level diagnostic test for straight motion kinematics material show that in the material there are still misconceptions experienced by students and this is indicated by several CDQs which show negative scores from the combination of students in all schools studied. This can happen because the average confidence level of students who answered incorrectly (CFW) is greater than the confidence level of students who answered correctly (CFC). A negative CDQ value indicates that there is a misconception that occurs, whereas if the CDQ is positive, it can be said that there is no misconception.

The researcher got six questions, all of which had a positive CDQ value. The six questions are number 1, 2, 3, 4, 9 and 10. Where questions number 1 and 2 explain the acceleration on the trajectory of objects. Questions 3 and 4 are questions related to distance and displacement. Meanwhile, questions number 9 and 10 are about motion that is affected by the acceleration of gravity. In questions number 1 and 2, the results of this study are different from those proposed by Wahyuni et al, (2018) where the concept of speed, speed and acceleration has a misconception rate of 38.33%, the average student still cannot distinguish between the speed and speed of students also do not understand well the definition of acceleration. Nasir (2020) also argues that students experience misconceptions of 28.12% in the acceleration and deceleration sub-topics. In this section, students experience misconceptions in understanding the concept of acceleration. Students assume that acceleration means the displacement of an object's position, whereas according to physics theory acceleration is a change in the velocity of an object in a certain time interval.

Questions number 3 and 4 have a positive overall CDQ value, which means that in this study, all students can be said to have no misconceptions about distance and displacement. Not in line with previous research according to Ince (2018) and Prasetyo (2020) where the percentage of student difficulties in each sub-sub-material, namely the distance and displacement sub-material is 59.55%.

For questions number 9 and 10 about motion influenced by gravitational acceleration, there are also no misconceptions, it is different with Rahmah, et al (2020) where in the sub-concept of regular straight motion the level of misconception is 37.77%. Students are still unable to describe the characteristics of uniform straight motion and cannot distinguish between the positions of objects experiencing GLB and GLBB.

Meanwhile, at the first level, it can be seen that the negative CDQ values are numbers 5, 6, 11, and 12. This indicates that all students have misconceptions about the answers to these items. Furthermore, at the third level, it can be seen that the negative CDQs are numbers 5 and 7, which means that all students experience misconceptions about the reasons for these items. For the combined CDQ from the first and third tiers (which answered both correctly and both incorrectly) which had a negative sign were numbers 5, 6, 7, 8, 11, and 12, meaning that it could be said that students had misconceptions about the relationship between answers and reasons.

After getting the results of the three CDQs from each question, the number that has a negative value must be confirmed for its significance by looking at the percentage of participants. Misconceptions will be said to be significant if experienced by at least 10% of the participants (Caleon, 2010).

In question number 5, there are three negative CDQ values, with the first tier CDQ showing -0.02,

the third -0.14, and for a combination of the two it is at -0.06. A misconception is said to be significant if it has a percentage value of 10% of the participants who chose the answer (Caleon & Subramaniam, 2010). The researcher found a very large percentage value, namely 49.17% with a CPM of 2.37. This misconception is in accordance with Nasir's research (2020) where the sub-topics of speed and speed have a misconception that is 34.03%. In Nasir's research, students assume that the speedometer in motorized vehicles is a speed measuring tool, whereas the speedometer (speed = speed) is a speed measuring instrument because it only measures the speed of the vehicle. In the position sub-concept, distance and displacement students have misconceptions by 33.33%. In general, students have misunderstandings in distinguishing between distance and displacement. Generally, students assume that the method of determining the two quantities is the same. In fact, displacement is measured by taking into account the initial position and final position of the object.

For question number 6, the value of the CDQ obtained is different. The first and combined levels have a negative value, but the reason level has a positive value. However, the significant value of the percentage is in the range of less than 10%. The researcher's findings are not in line with previous research where Rohmah (2018) found that the percentage of misconceptions is 0.39% in the matter of Straight Motion Changing Regularly. In this question, students are required to be able to understand the concept of GLBB. However, students are fooled into constant acceleration and constant acceleration, so students are not able to answer correctly.

Problem number 7, only has a negative CDQ value on the reason and combined tiers. Where the significant percentage is at 35%. Rahmah et al, (2020) explain that the concept of velocity, velocity and acceleration has a misconception rate of 38.33%, on average students still cannot distinguish between speed and speed, students also do not understand the definition of acceleration well. In the sub-concept of uniformly changing straight motion, the misconceptions experienced by students are 46.67 %, students are still unable to distinguish between uniform straight motion, accelerated straight motion and slowed GLBB, some students are also unable to describe examples of the application of GLBB in everyday life. -day,

In contrast to the others, in question number 8, only one CDQ was found with a negative value, namely at the combined level, while the answer level CDQ value and the reason for it had a positive value. With a CPM value of 2.44 and a significance in the range of 46%, it indicates that the researcher found a misconception on this item. Previous research by Nasir (2020) on the sub-subject of vertical motion obtained a misconception value of 38.02%. In general, students experience misconceptions in determining the value of velocity and acceleration of objects that experience vertical motion up, down or free fall. Students also still have a wrong conception of the value of the object's acceleration at the highest point. They assume the value of this acceleration is zero because the object stops momentarily.

In numbers 11 and 12, how many are in the same sub-topic, namely the Free Fall Movement. For item number 11, there is one positive CDQ value in the reason tier, and two negative CDQ values in the answer tier and the combined tier. However, the percentage significance value is not more than 10%. It is different with number 12 which has a combination of CDQ values similar to number 11, but the significant percentage obtained is high. Previous research conducted by Rahmah et al, (2020) on free fall motion, the level of misconception experienced by students was 58.33%. In the sub-concept of free fall motion, the percentage of misconceptions is the highest, because many students do not know the definition of the concept of free fall motion and also cannot distinguish free fall motion from vertical downward motion.

3.2 Causes of Students' Misconceptions Errors in reading books and information obtained from friends

Based on the results of the study, it was stated that students who experienced misconceptions regarding the truth of physics concepts were due to errors in reading books and information obtained from friends. The same thing was said by Setiawan (2020) that misconceptions can also occur due to errors in teaching materials. Book recommendations and information from friends may experience errors because the sources obtained are not valid and accurate (Yolanda, 2021).

This error is caused by students who trust the truth to their friends too much, so they are given book recommendations and given wrong information. The understanding possessed by friends is also not said to be correct because they are still both at the learning stage. So, friends will still be wrong to give book recommendations and information.

As a way to avoid these misconceptions by asking physicists for information and book sources or to teachers directly in order to get valid information and book sources so that there are no misconceptions about the actual physics theory.

3.3 Student Error Listening to Teacher's Explanation

Students' mistakes in listening to the teacher's explanation can cause misconceptions about the actual theories of physics concepts. This is influenced by the behavior of students who are less focused on paying attention to the teacher in class where the teacher explains learning material about physics concepts but the student does not have high concentration. The same thing was said by Purnamasari et al (2021) that misconceptions can occur because students in understanding the concept are still wrong and are caused by not listening to the teacher's explanation.

Case This will cause students to have misconceptions about the material presented by the teacher. Students in this condition act busy alone in class and joke with their friends in class so they don't pay close attention to the teacher.

This loss of focus causes students to have errors in listening to the explanations that have been delivered by the teacher so that it can be fatal in understanding the real concepts of physics theory. Students will eventually have misconceptions about physics concepts.

3.4 Personal Experience Misunderstanding Reading From Books and Media

As students, they will try independently to find information about their learning materials both from books and from media sources such as the internet. However, students who personally extract sources of information related to their learning materials will have a bad impact on these students.

Case This will cause students to experience misconceptions about actual physical theories. This happens because students who do not have basic knowledge of physics concepts so they decide to conduct personal searches either through books or via the internet, they will have different perceptions in understanding the material they read.

In contrast to a student who is explained by a teacher who is experienced and has knowledge that is more related to concepts in physics, so that if students experience errors in understanding, the teacher will correct them. However, if students independently dig up information and look for material self-taught, then when they experience errors in understanding they will not get corrections from an expert so that it will lead to misconceptions.

In addition, the search for material information either through the internet or books cannot be done randomly. Because, not all of the sources that come from the internet or books have the

originality and validity of the material. Thus, students must be careful in finding information related to physics concepts independently because there are many sources from the internet that are not accurate and valid.

Students in this case must try to filter the information data obtained so that there are no misconceptions about the physics material. This student's personal experience in finding information independently through the internet and books is the main factor causing students to experience misconceptions because the source obtained cannot be ascertained compared to getting information from someone who really has expertise in the field of physics such as a physics teacher at school.

3.5 The Teacher's Explanation Is Incorrect

Wrong One of the causes of students experiencing misconceptions regarding concepts in physics is due to the teacher's explanation. Teachers have an important role in the teaching and learning process in the classroom. Teachers must be able to master the learning material to be able to convey the material to students properly and correctly.

Teacher have a responsibility to convey their knowledge. A teacher who is wrong in conveying knowledge will cause the next generation to also be wrong in understanding the concept of learning. This does not stop there but will continue to be understood for generations to come. The role of the teacher should be able to explain in detail so that students do not have misconceptions about the concepts in learning, especially physics subjects.

Before starting learning, a teacher is required to study first to re-understand and re-learn the learning material that will be delivered that day. Thus, it will minimize the occurrence of errors in explaining. The slightest error in explaining can cause students to experience misconceptions about the learning material presented. The delivery and delivery model of a teacher must be precise and clear so that there are no misconceptions for students.

4. CONCLUSION

The misconceptions identified with the largest percentage are in the concepts of distance, position, and displacement of 49.17%. Furthermore, in the concept of vertical motion there are as many as 46%. In the GLBB concept, 35% of misconceptions occur. Then the misconception on the question of free fall motion with 3 different percentages for each combination of answers and reasons, the first 25.83%, then 18.33%, then 15%. This misconception occurs in students because it is caused by several factors. These factors include errors in reading books and information from friends, errors in listening to teacher explanations, personal experiences that cause misinterpretation of the material being studied and teacher explanations that are not appropriate in conveying material and physics concepts.

5. REFERENCES

Baghestani, A. R., Ahmadi, F., Tanha, A., & Meshkat, M. (2019). Bayesian critical values for Lawshe's content validity ratio. *Measurement and Evaluation in counseling and Development,* ***52***(1), 69-73. https://doi.org/10.1080/07481756.2017.1308227

Batlolona, J. R., Baskar, C., Kurnaz, M. A., & Leasa, M. (2018). The improvement of problem-solving skills and physics concept mastery on temperature and heat topic. *Jurnal Pendidikan IPA Indonesia, 7*(3), 273-279. https://doi.org/10.15294/jpii.v7i3.12432

Caleon, I. S., & Subramaniam, R. (2010). Do students know what they know and what they don't know? Using a four-tier diagnostic test to assess the nature of students' alternative conceptions. *Research in Science Education,* ***40***(3), 313-337. https://doi.org/10.1007/s11165-009-9122-4

Caleon, I., & Subramaniam, R. (2010). Development and application of a three-tier diagnostic test to assess secondary students' understanding of waves. *International journal of science education,* ***32***(7), 939-961.

https://doi.org/10.1080/09500690902890130

Gunawan, G., Suranti, N. M. Y., Nisrina, N., & Herayanti, L. (2018). Students' problem-solving skill in physics teaching with virtual labs. *International Journal of Pedagogy and Teacher Education,* ***2***, 10-87. https://doi.org/10.20961/ijpte.v2i0.24952

Harefa, A. R. (2019). Peran Ilmu Fisika Dalam Kehidupan Sehari-Hari. *Warta Dharmawangsa,* ***13***(2). 1-10. https://doi.org/10.46576/wdw.v0i60.411

Ince, E. (2018). An Overview of Problem Solving Studies in Physics Education. *Journal of Education and Learning,* ***7***(4), 191-200.

Inggit, S. M., Liliawati, W., & Suryana, I. (2021). Identifikasi Miskonsepsi dan Penyebabnya Menggunakan Instrumen Five-Tier Fluid Static Test (5TFST) pada Peserta Didik Kelas XI Sekolah Menengah Atas. *Journal of Teaching and Learning Physics, 6*(1), 49-68. https://doi.org/10.15575/jotalp.v6i1.11016

Khoiri, H., Wijaya, A. K., & Kusumawati, I. (2018). Identifikasi miskonsepsi buku ajar fisika SMA kelas X pada pokok bahasan kinematika gerak lurus. *JIPF (Jurnal Ilmu Pendidikan Fisika),* ***2***(2), 60-64. https://dx.doi.org/10.26737/jipf.v2i2.259

Lawshe, C. H. (1975). A Quantitative Approach to Content validity. *Personnel Psychology,* ***28***(4), 563-575.

Nasir, M. (2020). Profil Miskonsepsi siswa pada materi kinematika gerak lurus di SMA Negeri 4 Wira Bangsa Meulaboh. *JPF (Jurnal Pendidikan Fisika) Universitas Islam Negeri Alauddin Makassar, 8*(1), 61-66. https://doi.org/10.24252/jpf.v8i1.12245

Nurdiansyah, F., Wijaya, A. K., & Murdani, E. (2018). Miskonsepsi buku ajar fisika sma kelas x pada pokok bahasan dinamika gerak. *JIPF (Jurnal Ilmu Pendidikan Fisika),* ***3***(1), 31-34. https://dx.doi.org/10.26737/jipf.v3i1.440

Prasetyo, Z. K. (2020). The Development of a Metacognition Instrument for College Students to Solve Physics Problems. *International Journal of Instruction,* ***13***(1). 767-782. https://doi.org/10.29333/iji.2020.13149a

Purnamasari, W. I., Hamdani H., & Kartono K. (2021) Miskonsepsi siswa pada materi penjumlahan dan pengurangan pecahan campuran dengan bilangan asli kelas V SD. *Jurnal Pendidikan dan Pembelajaran Khatulistiwa,* ***10***(9). 1-10.

Rahmah, C. M., Nasir, M., & Bahri, S. (2020). Identifikasi Miskonsepsi Menggunakan Certainty Of Response Index (CRI) pada Materi Kinematika Gerak Lurus di MAN 4 Aceh Besar. *Jurnal Phi; Jurnal Pendidikan Fisika dan Terapan,* ***2018***(2). 5-10. http://dx.doi.org/10.22373/p-jpft.v2018i2.7457

Rohmah, Z. & Handhika, J. (2018). Two-Tier Diagnostic Test as an identification of misconceptions in the early stages of linear motion kinematics material for Class X MIA MAN 1 Madiun City students. In *Quantum: National Seminar on Physics, and Physics Education.* 552-556.

Setiawan, Y. E. (2020). Analisis kesalahan siswa dalam menilai kebenaran suatu pernyataan. *Jurnal Didaktik Matematika,* ***7***(1), 13-31. https://doi.org/10.24815/jdm.v7i1.14495

Shafwatul, A. N. A. M., Widodo, A., Sopandi, W., & Wu, H. K. (2019). Developing a five-tier diagnostic test to identify students' misconceptions in science: an example of the heat transfer concepts. *İlköğretim Online*, 1014-1029. https://doi.org/10.17051/ilkonline.2019.609690

Shrotryia, V. K., & Dhanda, U. (2019). Content validity of assessment instrument for employee engagement. *Sage Open,* ***9***(1), 2158244018821751.

Silviani, R., Muliyani, R., & Kurniawan, Y. (2020). Application of Three-Tier Test for Identification of Misconception Student Quantity on Magnetic Pole. *International Journal of Multi Discipline Science (IJ-MDS),* ***3***(1), 22-25. https://dx.doi.org/10.26737/ij-mds.v3i1.2393

Soeharto, S., Csapó, B., Sarimanah, E., Dewi, F. I., & Sabri, T. (2019). A review of students' common misconceptions in science and their diagnostic assessment tools. *Jurnal Pendidikan IPA Indonesia,* ***8***(2), 247-266. https://doi.org/10.15294/jpii.v8i2.18649

Suprapto, N. (2020). Do we experience misconceptions?: An ontological review of misconceptions in science. *Studies in Philosophy of Science and Education,* ***1***(2), 50-55. https://doi.org/10.46627/sipose.v1i2.24

Widiyatmoko, A., & Shimizu, K. (2018). The Development of Two-Tier Multiple Choice Test to Assess Studentsâ€™ Conceptual Understanding about Light and Optical Instruments. *Jurnal Pendidikan IPA Indonesia,* ***7***(4), 491-501. https://doi.org/10.15294/jpii.v7i4.16591

Wahyuni, S., Djudin, T., & Oktavianty, E. (2018). Integrasi Remediasi Miskonsepsi Siswa Menggunakan Model Problem Based Learning Dalam Pembelajaran Fluida Statis Di Sma. Jurnal Pendidikan dan Pembelajaran Khatulistiwa, 7(7). 1-11. http://dx.doi.org/10.26418/jppk.v7i7.26598

Yolanda, F., & Sthephani, A. (2021). Analisis Kesalahan Mahasiswa Pendidikan Matematika UIR pada Penyelesaian Analisis Kompleks. *SJME (Supremum Journal of Mathematics Education),* ***5***(1). 32-42. https://doi.org/10.35706/sjme.v5i1.4393