

Students' Misconceptions and the Causes on Straight Motion Materials Using Six-Tier Multiple Choice

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ABSTRACT

In physics studies, students experience misconceptions in physics learning, no exception to straight motion materials. These misconceptions can be identified using diagnostic tests, but diagnostic tests are not yet available in schools. To solve this problem, a test instrument is needed that can identify student misconceptions on direct motion material. The aim of this research is to analyze students' misconceptions and their causes regarding straight movement. The instrument used is the Six Level Multiple Choice which consists of 17 six level multiple choice elements on rectilinear motion material. This type of research is quantitative descriptive. The population of this study was eleventh class of natural sciences State High School in Bungo district. The sample in this research is five schools in Bongo district with the number of respondents is 127 students. The highest misconception was found in High School E, 35.29% and the lowest was found at High School A, 15.03%. The main cause of misconceptions in students was from the personal thinking of students 76.57% of the total of 22 students.

Keywords : Causes of misconceptions; Misconceptions; Six-tier multiple choice.



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I. INTRODUCTION

Physics learning can help students use their logic to solve everyday problems [1]. Therefore, physics learning is learning about everyday phenomena and symptoms of nature that can be studied through activities based on scientific attitudes, such as experiencing, observing, and experimenting. In the learning process, learners may use concepts they have previously learned to deal with new symptoms, or they may even be asked to replace and change concepts that they have already learned. [2]. However, most students are unable to connect the ideas learned from the book with their surroundings. [3]. During school, students see physics as a difficult lesson, and it becomes more difficult when they enter college [4]. So there's a lot of misconception in the students.

In education, educators often encounter students whose conceptual understanding is different from that accepted by experts and scientists. Different ideas are called misconceptions or different concepts [2]. Misconceptions occur in various fields of science, one of them is physics. This is because physics is so abstract that it students find it difficult to understand concepts correctly. Misconception is a misunderstanding of the subject matter that can cause an inconsistency between what a person has learned and what scientists have learned. [5].

Understanding the wrong concepts by students has a great influence on their learning. Regular misconceptions will affect how well students will learn in the future. Misconceptions that arise among students hinder learning [6]. This is because students believe more in their own theories and challenge experts.

If not handled properly, misconception will lead to poor learning outcomes for students. The influence of misconceptions has been put forward by many studies in Indonesia. The cognitive conflict approach was used to reduce misconceptions in 1st Grade Semarang. He found that after student misconception was successfully reduced, student learning results increased. Misconceptions affect learning outcomes, according to both studies.

Misconceptions can hinder learning. It's very influential on students in physics learning. According to Mufit & Fauzan, a misunderstanding of physical lessons by students will affect further physical learning. Misconceptions can damage student science buildings [7]. As a result, students will have difficulty in linking the physics theory they learned at school with the things they do every day. They will also have trouble studying other interrelated subjects when their misconceptions are not corrected. [8]. In his research Yolanda (2017) stated that straight-moving matter is one of many misconceptions that occur in physics. Physics lessons on straight motion study the symptoms of nature associated with the movement of objects that form a straight trajectory [9]. Proper understanding of concepts is essential to building structured knowledge of learners to solve phenomena in objects moving in a straight line. Learning misconceptions are issues that impact not just one subject but also the subsequent one that is related to it. Misunderstandings might affect a student's academic performance. The teacher needs to be aware of misconceptions regarding subconcepts in order to help students overcome this inaccurate concept or misconception [10].

The students is difficult to calculate the magnitude of speed, acceleration, distance, and movement in direct motion matter [11]. Zakiyyatur showed that the students had misconceptions of straight motion material of 44% on free fall motion, 21% speed and acceleration, 32% vertical upward movement, 5% on the concepts of distance and movement, 32%, on the speed movement, 16% on GLB concept, and 39% on GLBB concept. In addition to the misconception of the students themselves, teachers are also responsible for this problem. To prevent students from experiencing misconceptions on direct motion material in physics lessons, the identification of misconception and its causes is important to do [12]. Because misconceptions can be dispelled with clear information, it is important to identify and assess them before and after learning [13]. Diagnostic tests can be used to find the source of misconception and its causes.

Diagnostic tests are performed to determine whether the student has misconception or not. It is also used to determine the cause of student failure in the learning process [14]. Diagnostic tests are a type of test that can reveal a student's strengths and weaknesses in a particular subject. [15]. According to Zhongbao Zhao (2013) the primary objective of a diagnostic test is to identify students' strong and weaker points as well as provide input to teachers and students in the decision-making process regarding improvement in teaching and learning processes. To identify student misconception, the one-level double choice issue has been changed to two levels, three levels, four levels, and five levels [16]. The question, the level of certainty of the answer, the degree of belief of reason, and one additional question of an open nature are part of the five-level diagnostic test. Combining one question element into a misconception diagnostic test can help reduce the likelihood of assumptions made by students [17]. One of these additional questions can be a picture test, a conclusion drawing, or any other type of test that suits the needs of each subject. [18]. More data on the conception of students will be collected through the five-level diagnostic examination. [19]

In the material on the rectilinear motion of the five-level instrument coined by Hidayatullah is used for the process of analysing student misconceptions by adding another level (tier) namely six tier to find out the cause by the Dewi Ratna Sari [20].

Based on interviews with physics teachers in five schools, there are still many students who have little knowledge about linear motion material. Based on this, an identification process is needed to find out errors related to the linear motion material model. Therefore, this research aims to analyze the content and reasons for students' misunderstandings regarding linear motion material at the Bungo district high school.

II. METHOD

This type of research is quantitative descriptive research. This descriptive research was carried out to look for a realistic picture without focusing students' attention on the facts of the situation being investigated. Quantitative approaches are techniques that use numbers, starting with data collection, data analysis, and presentation of findings. [21]. The sample was 127 students from five schools in Bungo district. Here's the form of the six-tier double-optional instrument used.


I													
<p>1.1 Living things consist of humans, animals and plants. One characteristic of living things is movement. Which of the following statements is true</p> <div style="text-align: center;">  <p>Figure 1.1 Some children run</p> </div> <p>A. An object is said to be moving if the object changes its position with respect to its reference point B. An object is said to be moving if the object's velocity changes with respect to its reference point C. An object is said to be moving if the object experiences a change in acceleration in terms of its reference point D. An object is said to be moving if the object experiences a change in speed in terms of its reference point E. An object is said to be moving if the object experiences a change in velocity in terms of its reference point</p> <div style="text-align: center;"> <table border="1" style="display: inline-table; border-collapse: collapse;"> <tr> <td style="padding: 2px 5px;">A</td> <td style="padding: 2px 5px;">B</td> <td style="padding: 2px 5px;">C</td> <td style="padding: 2px 5px;">D</td> <td style="padding: 2px 5px;">E</td> </tr> </table> </div>	A	B	C	D	E	<p>B. Because moving is seen from the change in position of the object, position is the position of a point with respect to a certain reference</p> <p>C. Moving seen from the speed of the object, the speed of the object is the distance divided by the time</p> <p>D. Moving seen from the speed of the object, the speed is a change in the position of the object</p> <p>E. Because moving in is one of the characteristics of living things</p> <div style="text-align: center;"> <table border="1" style="display: inline-table; border-collapse: collapse;"> <tr> <td style="padding: 2px 5px;">A</td> <td style="padding: 2px 5px;">B</td> <td style="padding: 2px 5px;">C</td> <td style="padding: 2px 5px;">D</td> <td style="padding: 2px 5px;">E</td> </tr> </table> </div>	A	B	C	D	E		
A	B	C	D	E									
A	B	C	D	E									
<p>1.2 What is the level of confidence in the answers above?</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="padding: 2px 5px;">A</td> <td style="padding: 2px 5px;">Sure</td> </tr> <tr> <td style="padding: 2px 5px;">B</td> <td style="padding: 2px 5px;">Not sure</td> </tr> </table>	A	Sure	B	Not sure	<p>1.4 What is the Confidence Level for the reasons above?</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="padding: 2px 5px;">A</td> <td style="padding: 2px 5px;">Sure</td> </tr> <tr> <td style="padding: 2px 5px;">B</td> <td style="padding: 2px 5px;">Not sure</td> </tr> </table>	A	Sure	B	Not sure				
A	Sure												
B	Not sure												
A	Sure												
B	Not sure												
<p>1.3 Reasons for answer 1.1</p> <p>A. Because a moving object is seen from the distance of the object, the distance is the length of the path of an object</p>	<p>1.5 Write the definition of velocity, displacement, position, and speed in full!</p>												
<p>1.6 Sources of information used:</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="padding: 2px 5px;">A.</td> <td style="padding: 2px 5px;">Book</td> <td style="padding: 2px 5px;">D.</td> <td style="padding: 2px 5px;">Internet</td> </tr> <tr> <td style="padding: 2px 5px;">B.</td> <td style="padding: 2px 5px;">Teacher</td> <td style="padding: 2px 5px;">E.</td> <td style="padding: 2px 5px;">Other :</td> </tr> <tr> <td style="padding: 2px 5px;">C.</td> <td style="padding: 2px 5px;">Personal thoughts</td> <td></td> <td></td> </tr> </table>	A.	Book	D.	Internet	B.	Teacher	E.	Other :	C.	Personal thoughts			
A.	Book	D.	Internet										
B.	Teacher	E.	Other :										
C.	Personal thoughts												

Figure 1. Instrument Six-tier Multiple Choice

The Six Level Multiple Choice Instrument includes first level multiple choice questions. Next, it is related to the level of certainty of students answering basic level questions. Next focuses on the reasons behind the student's response. The another includes the level of certainty that understudies have in giving defense. The fifth level is an outline, conclusion or brief clarification made by understudies on the subjects given. The last mentioned is the cause of students' misconception of concepts.

Six Level different choice instrument to analyze students' misguided judgments around rectilinear movement fabric. This instrument has been tried for legitimacy, unwavering quality, differential quality and trouble file. The construction validity analysis results, the entire question is in valid condition. The reliability test of this research instrument is a high criterion. So the reliability of the instrument can be concluded as good and usable. The instrument's gap ranges from 0.3 to 0.6. The difficulty index of the question is in the middle category, which means the result of the power index varies from 0.5 to 0.7. Hidayatullah in Dewi Ratna Sari [20]

Students' answers data obtained after the application of six-level dual-optional instruments were then processed and analyzed to identify student misconceptions and their causes of misconception using the conceptual understanding categories presented by Anam dkk. (2019), in general student's level of understanding was gathered into six conceptual level categories comprising of Logical Conception (SC), Nearly Scientific Tradition (ASC), Need of Certainty (LC), and Bolt of Information. (LK), Misconcepts (MSC) and No Concepts. (HNC). Students who fall into the category of scientific conception mean students who are right in answering levels-1, level-3, and level-5. And respond with confidence in tier-2 and tier-4. Students that fall into category of near-scientific conception are students who answer correctly and confidently from level 1 to level 4, but are wrong in level 5. Next, students that are grouped into categories of less confident are students that answer right in level 1, level 3, and level-5. However, they are not confident between Tier-2 and Tier-4 or are not convinced with both. Students in category of less knowledge are students which answered correctly in 2 or 3 of 5 levels [18].

III. RESULTS AND DISCUSSION

1. Profile of Students Misconceptions in Physics Learning Materials in Straight Motion.

Students' misconception profiles are shown in the categories of understanding concepts, almost understanding concept, insufficient confidence, lack of knowledge, misconceptions, not understanding the concepts of every detail of the subject. The recurrence and rate of students' level of understanding on subjects

number 1 to 17 tried in 5 schools with tall, medium and moo categories in Bungo District State High School gotten the taking after comes about:

Table 1. Frequency and percentage of Students' Understanding Level

No	(SC)		(ASC)		(LC)		(LK)		(MSC)		(HNC)	
	n	%	n	%	n	%	n	%	n	%	n	%
Straight Motion Concept												
1	54	42.52	28	22.05	0	0.00	39	30.71	6	4.72	0	0.00
2	7	5.51	4	3.15	0	0.00	73	57.48	36	28.35	7	5.51
3	11	8.66	3	2.36	0	0.00	56	44.09	46	36.22	11	8.66
The Concept of Quantities in Straight Motion Concept												
4	3	2.36	28	22.05	0	0.00	39	30.71	41	32.28	16	12.60
5	9	7.09	41	32.28	0	0.00	41	32.28	21	16.54	15	11.81
6	4	3.15	25	19.69	0	0.00	64	50.39	19	14.96	15	11.81
Uniform Straight Motion Concept												
7	0	0.00	6	4.72	0	0.00	83	65.35	22	17.32	16	12.60
8	1	0.79	25	19.69	0	0.00	50	39.37	32	25.20	19	14.96
9	10	7.87	3	2.36	0	0.00	71	55.91	35	27.56	8	6.30
10	10	7.87	20	15.75	0	0.00	67	52.76	22	17.32	8	6.30
The concept of motion in a straight Line changes uniformly												
11	1	0.79	5	3.94	0	0.00	79	62.20	27	21.26	15	11.81
12	0	0.00	9	7.09	0	0.00	57	44.88	36	28.35	25	19.69
13	1	0.79	9	7.09	0	0.00	69	54.33	33	25.98	15	11.81
14	17	13.39	5	3.94	0	0.00	56	44.09	31	24.41	18	14.17
Magnitudes in Upward Vertical Motion												
15	15	11.81	10	7.87%	0	0.00	66	51.97	25	19.69	11	8.66
Magnitudes in Downward Vertical Motion												
16	0	0.00	6	4.72%	0	0.00	86	67.72	22	17.32	13	10.24
Magnitudes in Free Fall												
17	1	0.79	6	4.72%	0	0.00	53	41.73	43	33.86	24	18.90

Based on this table, it is stated that students has misconceptions on all the details of the subject. The highest misconception experienced by the students on the concept of straight movement material was 36.22% or 46 people out of 127 people in the sample. Next, the average percentage of students' conceptual understanding level is obtained which is shown in the following picture.

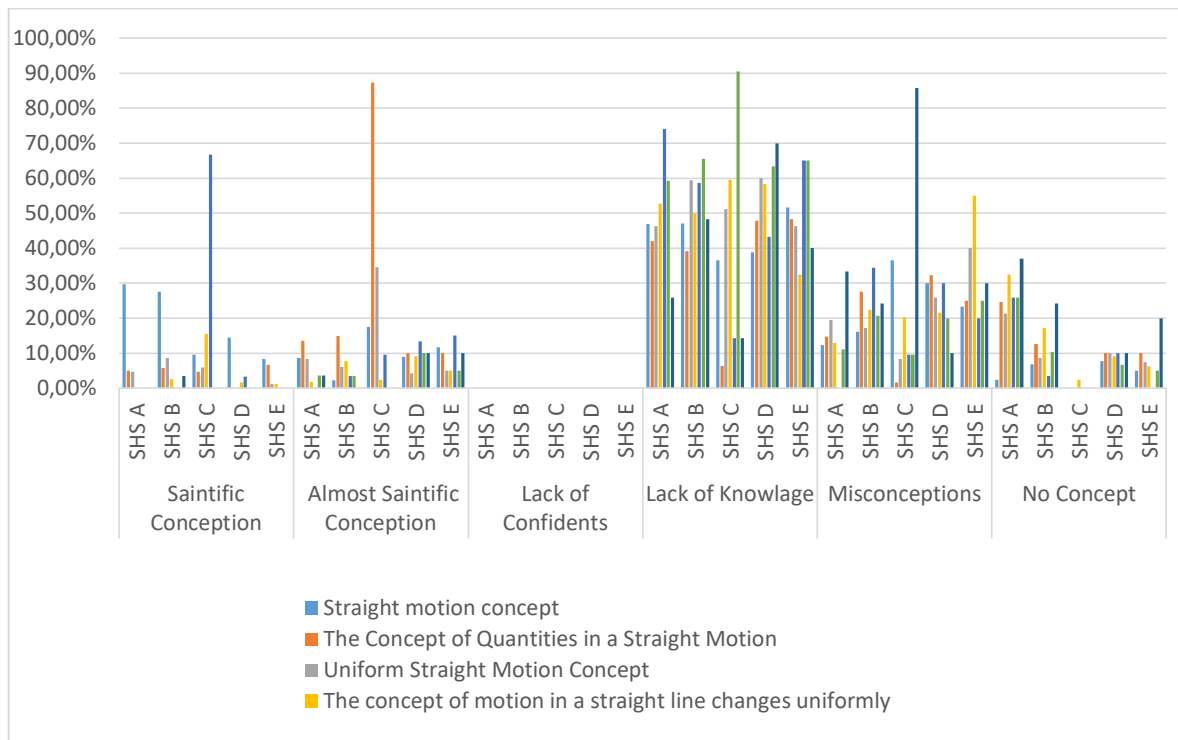


Figure1. Bar chart of the average percentage level of understanding of students in SHS A, SHS B, SHS C, SHS D, and SHS E.

Based on data surveyed on the graph, It was concluded that students experienced misconceptions about each detail of the subject assessed. The most significant misunderstanding was observed in the concept of rectilinear motion, with 46 of 127 samples reflecting the same.

Based on the over picture can be seen the normal rate of the level of understanding of the concept of coordinate movement fabric that happens within the understudies of the eleventh class of natural sciences High School district of Bungo distinguished employing a double-optional symptomatic test of six levels on tall, medium and moo. The categories gotten four levels of understanding of concepts, to be specific logical conceptions, near-scientific conception, need of information, and misinterpretations. By and large, 36.22% of understudies had misinterpretation, which was direct, whereas 42.52% of understudies who caught on the concept were direct.

The overall percentage of misconceptions is in the highest position, namely 36.22 percent. The number of questions, namely 17 questions, multiplied by a sample of 127 students, resulted in 2,159 questions being answered. Of the five schools, understudies who experienced the most elevated misinterpretations happened in Senior High School C regarding the concept of massive free fall motion with an normal understudy rate of 85.71%.. Whereas the lowest category of misconception also occurred at High school C where the characteristic concept of straight motion was regular with a percentages of 8.33%.

2. Description of student misconceptions on straight motion

The linear motion concept of this six-level multiple choice diagnostic test instrument includes three questions, namely questions number 1,2, and 3. The indicator of questions number 1 explains straight motion with the essential material of concepts, characteristics and applications of movements. On the details of this identified misconception. This includes a few misunderstandings that students may experience because not many students choose the explanation. If the position of an object moves when viewed from the focal point, then the object is said to be moving. Students who understand the concept on the subject matter are quite a lot of 42.52%. The indicator of the subject number 2 is to clarify the concept, characteristics and application of the movement. In this case, 28.35% of students suffered from misconception. Proved by 36 students who were confused with their answers and convinced with the answers. Indicator point number 3 contains about concluding concepts, characteristics and application of movements. In this case, there were 46 students who suffered misconception. Details about number three are the most common misconceptions. The student is still confused in

answering the reason for the answer with the cognitive category of the C4 question and convinced of the reason he answered. On this concept of straight movement, high school D is the school with the highest average misconception of 30.00%.

The concept of magnitude in straight motion is represented by three elements of matter, namely, the elements of number 4, 5, and number 6. Question number four indicator explains the magnitude of a straight motion with the level of C2 thinking ability. A total of 41 students suffered from misconception. 32.28% of the students were still mistaken in giving a reason. They assumed that the movement of an object is seen based on a change in the position of the object when it moves. It is true that such an understanding is wrong. Movement means a change in the position of an object. Clearly, displacement is how far an object is from its starting point. The indicator of the matter number 5 is comparing the difference and equality between the size of one and the other in a straight motion. The level of the ability to think on the matter is C5. A total of 16.54% of students suffered from misconception. Students who understood the concept answered that the distance is a scalar magnitude while the shift is a vector magnitude. The elementary indicator of the number 6 is still the same as the elementary indicator for the number 6, which compares the difference and equality between the one size and the other size in a straight motion. In this matter, not many students have misconceptions of 14.96%, misconception occurs because some students who answer speed only have position, while speed has distance. Besides, many students are mistaken in describing the speed and speed of objects moving at the fifth level. On the concept of magnitude on this straight movement, high school D is the highest average misconception of 32.22%..

The concept of regular straight movement is represented by the item number 7.8.9 and the number 10. The item indicator number 7 is a summary of the application of orderly straight movement in everyday life. In this item there are 17.32% of students who have misconception and 0.00% of learners have understanding of the concept. The item number 8 is the same that summarizes the use of the regular straight motion in daily life. On both sides of this, quite a few students suffer from misconception. This is because it contains a number with similarities that are easy to remember by the students. The equation used in the question is the commonly used equation $s=vt$. So it's not too difficult for the student to solve the question. Indicator point number 9 on clarifying properties of regular straight movement. A large number of students suffered from misconception, which was 27.56%. Students who understood the concept had 10 learning points, which is 7.87%. Students can answer the characteristics of uniform straight motion: the trajectory of objects in the shape of a straight line, the speed of a constant object, the acceleration of an object is zero, and the velocity of an constant object. In addition, there are not many students who answer the explanation confusedly. In fact, the number 10 indicator is an example of moving objects with regular straight movements in everyday life. A total of 17.32% of students have misconceptions. While the students who understand the concept there are 10 students, which is 7.87%. Because in the previous topic the students already have a lot of understanding about the characteristics of regular straight movement, so the students will not have difficulty in answering examples in daily life of such straight movement. On the concept of regular straight movement, high school E becomes a school with the highest average misconception of 40.00%.

The concept of linear change is represented by four elements, namely 11, 12, 13, and number 14. The linear indicators of numbers 11, 12 and 13 are the interpretation of magnitude values on the GLBB (linear change movement) based on the given illustration. A total of 21.26% of the pupils who suffered misconception on the 11th level are somewhat mistaken in giving reasons for the third level. In addition, the students are also confused in describing the graphic shape of the association of t to v in each type of movement of objects. In question number 12 and number 13, 28.35% for question number 12, and 25.98% for issue number 13 students who suffered misconception. In question issue 12, students were mistaken in answering questions and reasons for answers. The indicator on issue number 14 is an example of the application of Straight movements change regularly in everyday life. A total of 24.41% of students suffered from misconception. This figure is still low because most students understand about the characteristics of the Straight movements change regularly that it is straight-shaped, its speed changes regularly and its speed is constant. On the concept of straight movement change the rule of high school E into a school with the highest average misconception of 55.00%.

The concept of magnitude on vertical upward movement is represented by a matter of the number 15. The indicator on the number 15 is to conclude magnitudes on the vertical Upward movement. On the number 15, 19.69% of the students have misconceptions. It is still rated in the low category, as most of the students are in the concept understanding category. The final speed of an object is proportional to the initial speed plus the resulting times between the acceleration of the object and the time the object moves. On the concept of straight movement change the rule of high school D to school with the highest average misconception of 30.00%.

The concept of magnitude on the vertical motion down is represented by a matter of the number 16. The indicator on the number 16 is to conclude magnitudes on vertical movement down. 17.32% of students suffered from misconception. Misconception rates on this subject are among the lowest among misconceptions on other subjects. On the concept of magnitude on the vertical move down to high school E becomes the school with the highest average misconception of 25.00%.

The concept of magnitude on the vertical motion down is represented by a matter of the number 16. The indicator on the number 16 is to conclude magnitudes on vertical movement down. 17.32% of students suffered from misconception. Misconception rates on this subject are among the lowest among misconceptions on other subjects. On the concept of magnitude on the vertical move down to high school E becomes the school with the highest average misconception of 25.00%. The concept of magnitude in free fall motion is represented by a matter of matter number 17. The indicator in this matter is to sum up magnitudes on free fall movement, vertical upward movement, and vertical downward movement. Students who suffered misconception on the subject matter were 33.86%. The misconceptions rate on this subject matter was high among misconception on the other subject matter. On the concept of magnitude on the free fall movement of high school C became the school with the highest average misconception of 85.71%.

2. Causes of Misconceptions in Physics Learning Material in Straight Motion

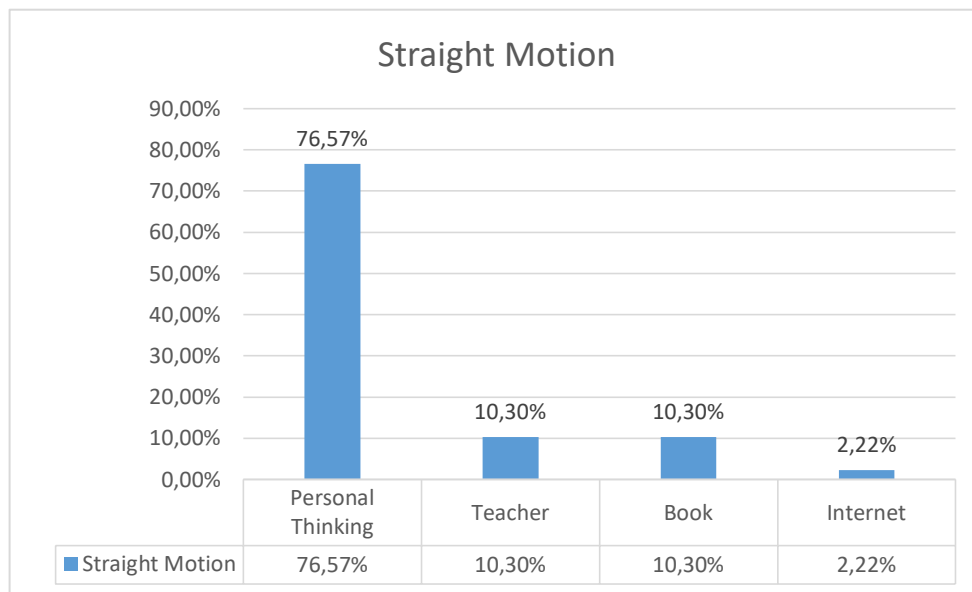


Figure 3. Bar diagram of the causes of misconceptions in straight motion

The cause of misconception in students is identified from the tier-6 shown in figure 6. Misconception experienced by students is not exempt from the cause of Misconception. Misunderstandings of this research are occurred mostly due to the personal thinking of students as many as 76.57%. Along with the concepts of physics based on their own experience. In this study, misconceptions caused by books and teachers were at the second level at 10.30%. Apart from that, the Internet is also a source of confusion.

IV. CONCLUSION

From the research and analysis of data showed that student misconception and its causes occurred in straight motion material in Bungo district high school overall the percentage of misconceptions that occurred was 22.93%. Misconceptions in direct motion material that owned the five schools namely in High school A was 15.03%, 21.70% in High School B, 19.61% in high school C, 25.69% in higher school D, and 35.29% in lower school E. The highest misconception occurred at High School E, followed by High School D, High school B, High School C, and the last is High School A that had the lowest misconception.

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