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

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Abstract: In physics learning, often encountered misconceptions experienced by students, one of which is in the material of straight motion. In addition to misconceptions, the causes of misconceptions also need to be known by the teacher. By knowing the misconceptions and their causes that occur to students so that teachers can improve the learning process and improve student learning outcomes. This study aims to analyze the profile of students' misconceptions and their causes in the material of straight motion. The instrument used in identifying misconceptions and their causes is Six-Tier Multiple Choice which consists of 17 multiple choice questions at six levels. The type of research used is descriptive research with a quantitative approach. The population in this study were students of class X MIPA SMA Negeri in Regency of Solok Selatan. The sample in this study were three schools with high, medium and low categories in Regency of Solok Selatan with a total sample of 195 students. Sampling in this study used a purposive sampling technique. Overall, the results of the study at SMA Solok Selatan Regency found that misconceptions were classified as low at 19.37%. The results showed that 17.57% of misconceptions occurred in SMA A, 21.48% in SMA B and 18.09% in SMA C. The highest misconceptions occurred in schools with moderate categories, followed by schools with low categories and schools with high categories. The main cause of misconceptions is the personal thinking of students with a percentage of 42.50%.

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

Introduction

Based on the 2003 Law on the National Education System, learning is a process of interaction between students and educators and learning resources in a learning environment. This interaction process occurs between students, students with learning resources as well as students and educators. Physics is one of the basic natural sciences that is widely used as the basis for other sciences. As a basic science, physics has characteristics that include facts, concepts, principles, laws, postulates, and scientific theories and methodologies (Mundilarto, 2010).

Understanding the concept is a requirement to succeed in learning physics (Mufit & Capriconia, 2022). Physics learning in schools aims to make students able to master concepts and principles and have the skills to develop the knowledge gained. In line with this, according to Setiawati & Jatmiko (2018) the purpose of learning physics is to develop reasoning abilities in analytical thinking of students using physics concepts and principles that explain events in everyday life and to solve problems both qualitatively and quantitatively. To achieve this goal requires a good understanding of students concept.

The level of students' understanding of a concept can be influenced by several things. One of them is the initial assumption or conception of students coming from everyday events that are experienced and natural phenomena or phenomena that students see (Rahayu & Hariyono, 2019). In addition, along with the development of technology, students also gain an understanding of the concept by accessing the internet through their smartphones. Understanding of a concept is also obtained by students through learning in the classroom. Students will build a concept after obtaining learning by formulating the principles obtained from learning with the initial assumptions they have. After

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that, students will conclude these concepts into an understanding.

In the world of education, educators often find students who have an understanding of concepts that deviate from concepts that are accepted by experts and scientifically. These deviant concepts are known as misconceptions (wrong concepts) or alternative concepts (Suparno, 2013), non-scientific beliefs, naive theories, mixed conceptions, or conceptual misunderstandings (Alwan, 2011). Misunderstanding of a particular event or concept experienced by a person as a result of the concept that has been built is not in accordance with the scientific understanding put forward by experts is called a misconception (Shalihah et al., 2016). Misconception is a mistake in understanding the concept of learning material that can cause a mismatch between the concepts possessed by someone with scientific concepts or concepts owned by scientists (Artiawati et al., 2016).

Understanding the wrong concepts in students is very influential on learning. Misconceptions will consistently affect the effectiveness of the students learning process in the future (Wahyuningsih et al., 2013). The impact of misconceptions that occur on students will hinder the learning process Hermita et al. (2017), because students will be more confident in the concepts they have and reject the concepts of experts. Akmali (2018) explains that misconceptions can have more severe effects and can hinder the development of science and technology if they occur in large numbers of students.

Misconceptions will result in low student learning outcomes if they are not followed up properly. The effect of this misconception has often been stated in various studies in Indonesia. Among them, Saehana et al. (2020), found in their research that one of the causes of low physics learning outcomes for high school students in Palu City is the high level of misconceptions. Then Mosik (2010) in his research that uses a cognitive conflict approach to reduce student misconceptions at SMP 1 Semarang gets student learning outcomes to increase after misconceptions are successfully minimized. From the two research results, it can be seen that there is an influence of misconceptions on learning outcomes.

Misconceptions can hinder learning progress (Mufit et al., 2019). This has a big impact on learning physics for students. The misunderstanding of physics learning by students will affect the next physics learning (Mufit & Fauzan, 2019). In physics subjects, there are very many misconceptions that occur, one of which is the material of straight motion (Yolanda, 2017). Straight motion is a physics learning material that observes natural phenomena related to the movement of an object that forms a straight path. Understanding the right concepts is needed in building students' knowledge in a structured way to solve various phenomena that occur in straight motion material.

In straight motion material, students find it difficult to identify the magnitudes of speed, acceleration, distance and displacement (Tarisalia, et al., 2020). Rohmah and Handhika (2018) explain the misconceptions about straight motion material that occur to students including 44% in free fall motion, 21% on the concept of speed and acceleration, 32% on vertical upward motion, 5% on the concept of distance and displacement, 32% on the concept of speed, 16% on the uniform straight motion, and 39% on the concept of motion in a straight line changes uniformly. In addition to misconceptions by the students themselves, in physics learning there are also misconceptions caused by educators.

Identification of misconceptions and their causes is needed to prevent students' misconceptions in learning physics in straight motion material. Identification and assessment of misconceptions is an important thing to do both before learning and after learning because handling misconceptions can be done effectively if the misconceptions are clearly known (Akmali, 2018). To identify misconceptions and their causes can be done by means of diagnostic tests.

Diagnostic tests are used to find out whether students have misconceptions or not and also the causes of students failing in the learning process (Suwarto, 2013) which are arranged in the form of multiple choice or multiple choice. According to Kirbulut and Geban (2014) multiple choice tests are a more efficient way of identifying misconceptions than interviews. However, this multiple choice also still has several weaknesses, such as when working on the problem, the answer can be guessed by students without the need to understand the material from the problem being worked on and the teacher also has difficulty making a homogeneous and functional distracting answer. To overcome these difficulties, the multiple choice test was developed into a multilevel model test starting from one tier/one level, two tier/two levels, three tier/three levels, four tier/four levels, and recently developed the five tier (Anam et al., 2019). Five-tier can be used to diagnose the conception of science (Rosita et al., 2020). In addition, it can analyze more deeply and assist teachers in improving student learning outcomes (Mufit et al., 2022). Various diagnostic test methods have been developed which each have their own advantages and disadvantages.

In the matter of straight motion, the five-tier instrument developed by Hidayatullah (2022) is used to analyze the students' misconceptions. Furthermore, to find out the cause of the misconception, one more tier was added, namely the six tier. A six-tier multiple choice instrument is needed in detecting misconceptions experienced by students as well as analyzing students'

understanding of the straight motion material and the causes of these misconceptions.

Based on the facts in the field at the three schools that were observed, the level of students' understanding of the concept of straight motion is still relatively low. The findings recorded at three public schools in South Solok were based on the daily assessments of test scores related to linear motion topics, which fell short of meeting the Minimum Completeness Criteria, namely the average value of class X students (ten) 60.50; 71.50 and 42.70. Based on the results of discussions with teachers of physics subjects in these three schools, there are still many students who have a low level of understanding on the material of straight motion. One of them is in the sub-material of distance and displacement. Students still assume that distance and displacement are the same whereas basically they are very different. Besides that, The teacher has also never carried out the identification process of the misconceptions experienced by students. Based on the above problems, an appropriate identification process is needed to detect misconceptions experienced by students in the material of straight motion. Therefore, this study aims to analyze the profile of students' misconceptions and their causes in the straight motion material at SMA Solok Selatan Regency.

Method

This type of research is characterized as a descriptive research using a quantitative methodology.. This descriptive research was conducted to find out the real picture without treating students systematically and accurately about the facts of the phenomena being investigated. The quantitative methodology is a technique that employs digits, commencing from data gathering, analysis of the data, and presentation of the findings (Arikunto, 2013). This research was conducted from April 27 to May 27, 2022. The number of samples was 195 students consisting of 77 students from SMA A, 55 students from SMA B and 63 students from SMA C. The following is the form of the Six-tier multiple choice instrument used.

1

1.1 Living things consist of humans, animals and plants. One characteristic of living things is movement. Which of the following statements is true

Figure 1.1 Some children run

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

A	B	C	D	E

1.2 **What is the level of confidence in the answers above?**

A	Sure
B	Not sure

1.3 Reasons for answer 1.1

A. Because a moving object is seen from the distance of the object, the distance is the length of the path of an object
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
C. Moving seen from the speed of the object, the speed of the object is the distance divided by the time
D. Moving seen from the speed of the object, the speed is a change in the position of the object
E. Because moving in is one of the characteristics of living things

A	B	C	D	E

1.4 **What is the Confidence Level for the reasons above?**

A	Sure
B	Not sure

1.5 Write the definition of velocity, displacement, position, and speed in full!

1.6 Sources of information used:

A.	Book	D.	Internet
B.	Teacher	E.	Other :
C.	Personal thoughts		

Figure 1. InstrumentSix-tier multiple choice

The Six-tier multiple choice instrument consists of the first level being multiple choice questions. The next tier pertains to the assurance level of pupils when responding to queries at the primary tier. The

succeeding tier focuses on the rationale behind students' responses. The subsequent tier involves the level of certainty that students possess in providing justifications. The fifth level is an image, conclusion or brief explanation made by students from the questions given. And the sixth level is the cause of misunderstanding the concept of students.

The six-tier multiple choice instrument was appropriate to be used to analyze the students' misconceptions on the straight motion material. This instrument has been tested for validity, reliability, discriminating power and difficulty index. The results of the analysis of construct validity, all questions are in a valid condition. The results of the instrument reliability test are included in the high criteria. So it can be concluded that the reliability of the instrument is good and feasible to use. The discrepancy of this instrument ranges from 0.3 to 0.6. The difficulty index of the questions is in the medium category, i.e. the results of the difference power index are in the range of 0.5 to 0.7 (Hidayatullah, 2022).

The student's answer data obtained after the deployment of the six-tier multiple choice instrument was then processed and analyzed to identify the existence of misconceptions in students and the causes of misconceptions by using the category table of concept understanding suggested by Anam et al. (2019), based on the table, the overall level of understanding of students is grouped into six categories of conception levels consisting of Scientific Conception (SC), Almost Scientific Conception (ASC), Lack of Confidence (LC), and Lack of Knowledge (LK), Misconceptions (MSC), and Have No Connception (HNC). Students belonging to the scientific conception category mean that students are correct in answering tier-1, tier-3, and tier-5. And answered confidently on tier-2 and tier-4. Students who are included in the almost scientific conception category are students who answer correctly and confidently on tier-1 to tier-4 but uncorrectly on tier-5. Furthermore, students who were grouped in the lack of confidence category were those who answered correctly on tier-1, tier-3, and tier-5. However, they were not sure between tier-2 and tier-4 or were not sure about both. Students belonging to the lack of knowledge category are those who answer correctly 2 or 3 of the 5 levels. Students who are classified as misconceptions are students who answer confidently on tier-2 and tier-4. But the wrong answer is in one or two tiers between tier-1, tier-3, and tier-5. Furthermore, students belonging to the have no connception category are students who are wrong and unsure at all levels.

Result and Discussion

Profile of Students' Misconceptions in Physics Learning Materials in Straight Motion

The student's misconception profile is displayed in the category of concept understanding, almost understanding the concept, lack of confidence, lack of knowledge, misconceptions, not understanding the concept of each item. The frequency and percentage of students' level of understanding on items number 1 to 17 which have been tested in 3 schools with high, medium and low categories at SMA Negeri Solok Selatan obtained the following results.

According to the data presented in the chart, it can be concluded that students have misconceptions about each item being assessed. the most significant misconception was observed in the concept of quantities in straight motion, with 49 of the 195 samples reflecting the same. Further data analysis obtained the percentage of the average level of understanding of students' concepts which is shown in the following figure.

Based on the picture above, it can be seen the average percentage level of concept understandingthe straight motion material that occurs in students of class X MIPA at SMA Solok Selatan Regency identified by using a six-tier multiple choice diagnostic test in high, medium and low categories obtained four categories of concept understanding levels, namely scientific conception, almost scientific conception, lack of knowledge, and misconceptions. Overall, students experience misconceptions of 19.37% which is classified as low. Meanwhile, 45.00% of students who experience scientific conception are classified as moderate.

The percentage of misconceptions as a whole occupies the highest position at 23.08%. The highest percentage of understanding concepts as a whole occupies the highest position of 55.38% in the medium category. A total of 17 questions were multiplied by the number of samples of 195 students, namely 1,615 questions that had been answered. Of the three schools, the students who experienced the highest misconceptions occurred in SMA C on the concept of quantities in the vertical downward motion with the average percentage of students being 28.57%. Meanwhile, the lowest category of misconceptions also occurred in SMA C where the characteristics of the concept of straight motion changed uniformly with a percentage of 13.89%. Almost from every straight motion material there are students who experience various misconceptions.

Table 1. Frequency and Percentage of Students' Understanding Level

No. Question	Understanding Concepts (PK)		Almost Understand the Concept (HPK)		Lack of Knowledge (KP)		Misconception (MSC)	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Straight Motion Concept								
1	118	60.51	23	11.79	33	26.92	21	10.77
2	72	37.00	35	18.00	45	23.00	43	22.00
3	73	37.00	27	14.00	48	25.00	47	24.00
The Concept of Quantities in Straight Motion								
4	76	38.97	26	13.33	47	24.10	46	23.59
5	105	53.85	21	10.77	43	22.05	26	13.33
6	76	38.97	36	18.46	34	17.44	49	25.13
Uniform Straight Motion Concept								
7	63	32.31	39	20.00	45	23.08	48	24.62
8	93	47.69	34	17.44	37	18.97	31	15.90
9	93	47.69	24	12.31	46	23.59	32	16.41
10	108	55.38	12	06.15	38	19.49	37	18.97
The concept of motion in a straight line changes uniformly								
11	92	47.18	33	16.92	40	20.51	30	15.38
12	78	40.00	34	17.44	45	23.08	38	19.49
13	85	43.59	34	17.44	38	19.49	38	19.49
14	97	49.74	28	14.36	39	20.00	31	15.90
Magnitudes in Upward Vertical Motion								
15	89	45.64	32	16.41	40	20.51	34	17.44
Magnitudes in Downward Vertical Motion								
16	67	34.36	31	15.90	52	26.67	45	23.08
Magnitudes in Free Fall								
17	108	55.38	12	06.15	38	19.49	37	18.97

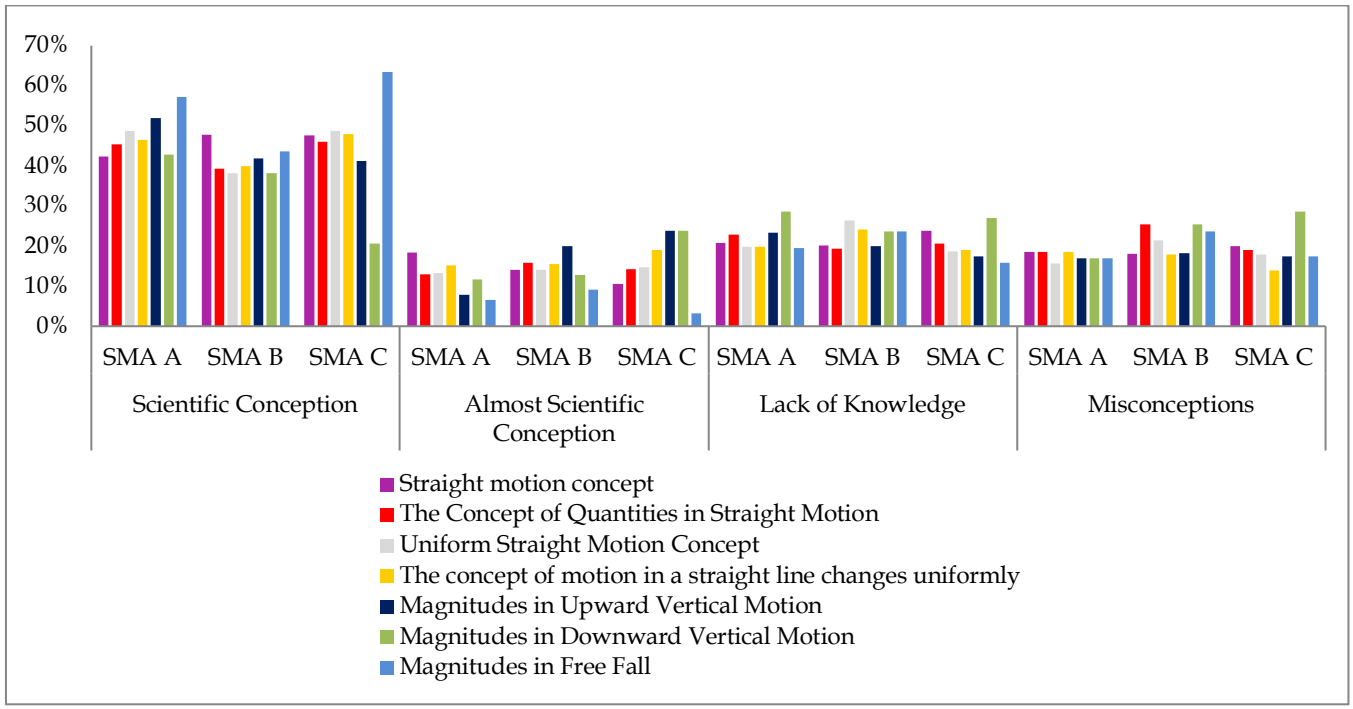

Figure 2. Bar chart of the average percentage level of understanding of students in SMA A, SMA B, and SMA C

Straight motion concept

The straight line consists of 3 questions, namely items number 1, 2, and 3. In item number 1, misconceptions are identified. This includes the lowest misconception experienced by students because not many students choose the answer that an object is said to be moving if the object experiences a change in position in terms of its reference point. In item number 2 as many as 22.00% of students experienced

misconceptions. Item number 3 contains 47 students who have misconceptions.

The concept of quantities in straight motion

The concept of quantities in straight motion is represented by 3 questions, namely in item numbers 4, 5, and number 6. In item number 4, 23.59% of students are still wrong in giving reasons. Item number 5 as many as 13.33% of students who experience misconceptions. There are quite a lot of students who understand the concepts in this item, namely 53.85%. Item number 6 is the question with the most misconceptions.

Uniform straight motion concept

The concept of uniform straight motion is represented by items number 7, 8, 9, and number 10. In item number 7 as many as 24.62% of students experienced misconceptions and 32.31% of students experienced scientific conception. Item number 8 as many as 15.90% of students who experience misconceptions. In item number 9, there are not many students who experience misconceptions, which is 16.41%. In item number 10, 18.97% of students experienced misconceptions. While students who scientific conception quite a lot that is equal to 55.38%.

The concept of uniformly changing straight motion

The concept of uniformly changing straight motion is represented by 4 items, namely 11, 12, 13, and number 14. A total of 15.38% of students experienced misconceptions in item number 11. In item number 12 and number 13, 19.49% of students experienced misconception. In item number 12, students are wrong in answering the questions and the reasons for the answers. In item number 13, students assume that the illustration of rhino movement is constant. In item number 14 as many as 15.90% of students who experience misconceptions.

The magnitudes of the vertical upward motion

The concept of quantities in the vertical upward motion is represented by 1 item, namely item number 15. In this item, 17.44% of students experience misconceptions. This is considered still in the low category, because most of the students are in the category of scientific conception.

The magnitudes of the vertical downward motion

The concept of quantities in the vertical downward motion is represented by 1 item, namely item number 16. This item as many as 23.08% of students experienced misconceptions.

The magnitudes of the free fall motion

The concept of quantities in free fall is represented by 1 item, namely item number 17. 18.97% of students who experience misconceptions about this item. There are also quite a lot of students who scientific conception on this item, namely 55.38%.

The data above will be presented in more detail in the following three schools with high, medium and low categories.

SMA A

The findings are derived from the analysis of research outcomes obtained from a six-tier instrument consisting of 17 questions. The questionnaire was administered to a sample of 77 students. The students were classified into three categories based on their level of scientific understanding: scientific conception, almost scientific conception, lack of knowledge, and misconceptions is shown in Figure 3.

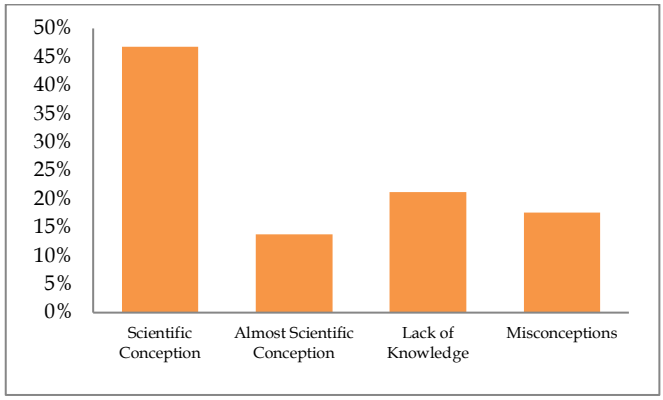

Figure 3. Bar chart of the percentage level of understanding of students in SMA A

Based on figure 3, the average percentage of students who experience misconceptions in SMA A is 17.57% with a low interpretation. Most students are categorized as understanding concepts with a percentage of 46.81% with moderate interpretation.

SMA B

The findings are derived from the analysis of research outcomes obtained from a six-tier instrument consisting of 17 questions. The questionnaire was administered to a sample of 55 students. The students were classified into three categories based on their level of scientific understanding: scientific conception, almost scientific conception, lack of knowledge, and misconceptions is shown in Figure 4.

Based on figure 4, it can be seen that the percentage of students who experience misconceptions in SMA B of 21.48% is interpreted as low. The category of understanding the concept is most experienced by students with a percentage of 41.04% being interpreted as being.

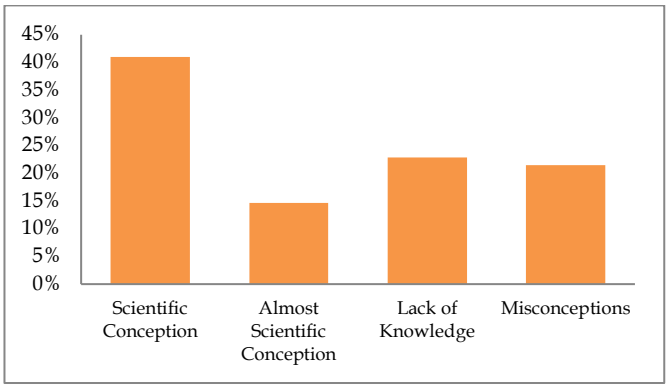

Figure 4. Bar chart of the percentage level of understanding of students in SMA B

SMA C

The findings are derived from the analysis of research outcomes obtained from a six-tier instrument consisting of 17 questions. The questionnaire was administered to a sample of 63 students. The students were classified into three categories based on their level of scientific understanding: scientific conception, almost scientific conception, lack of knowledge, and misconceptions is shown in Figure 5.

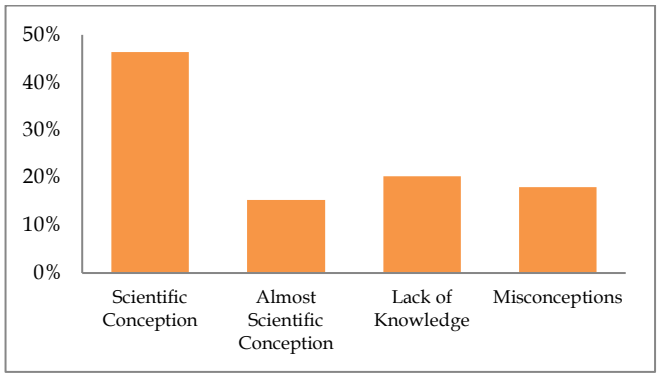

Figure 5. Bar chart of the percentage level of understanding of students in SMA C

Based on Figure 5, it can be stated that students experienced misconceptions on all the items tested. It can be seen that the average percentage of students who experience misconceptions in SMA C of 18.09% is interpreted as low. Most students are categorized as understanding concepts with an average percentage of 46.34%.

Causes of Misconceptions in Physics Learning Materials in Straight Motion

The causes of misconceptions in students are identified from tier-6 shown 6. The misconceptions experienced by students cannot be separated from the causes of misconceptions. In this study, the misconceptions that occur are mostly caused by the personal thoughts of students as much as 42.05%. Along with the results of research conducted by Fakhruddin et al. (2012), that personal thinking contributes 80% to students' misconceptions. Sources of misconceptions that come from personal thoughts occur when students have the assumption that a concept is always the same as another concept. Students often have misinterpretations by assuming the terms found in lessons and daily life are the same (Suparno, 2013). Students do not explore the correct concepts so that students assume the concepts they find by chance through everyday experience are the correct concepts.

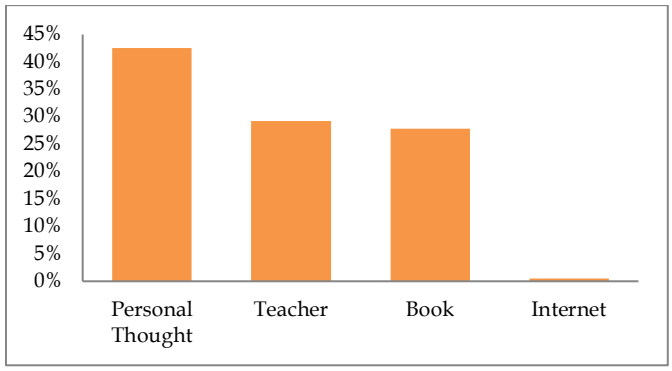

Figure 6. Bar diagram of the causes of misconceptions in straight motion material

In addition to the personal thoughts of the students themselves, misconceptions can also be caused by the teacher. In this study, misconceptions caused by teachers are in second place at 29.23%. As per the research conducted by Mufit el al. (2019), the root of misunderstandings and challenges faced by students while comprehending concepts of physics is the approach of teaching that is focused on the teacher. Students only receive information and concepts from the explanations given by the teacher so that students are not active in the learning process and do not build physics concepts based on their own experiences. In addition, teacher-focused learning causes students to fail to understand fundamental ideas and instead only focus on memorizing formulas (Mufit et al., 2020). Another factor contributing to students' misunderstandings is the learning materials. Books cause 27.80% of students have misconceptions. In addition, the internet is also one of the causes of misconceptions.

Conclusion

The findings of the study and statistical analysis indicated that students' misconceptions and the causes of their occurence in straight motion material at SMA regency of Solok Selatan, the overall average percentage of misconceptions that occurred as a whole was 23.08%. The misconception that schools have in the high category is SMA A by 17.57%. Schools with the medium category, namely SMA B, experienced a misconception of 21.49%.

The school with the low category is SMA C with a misconception of 18.09%. The highest misconceptions occurred in schools with moderate categories, followed by schools with low categories and schools with high categories. From the analysis of the causes of students' misconceptions on the material of straight motion, it was found that the main cause of misconceptions was the students' personal thoughts with a percentage of 42.50%.

References

Akmali, A. A. (2018). A Construction of Four-Tier Test to Identify the Misconceptions' Level and Source on Material of Heat. *Jurnal kependidikan*, *2*(2), 274-284. https://doi.org/10.21831/jk.v2i2.13165

Alwan, A. A. (2011). Misconception of Heat and Temperature Among Physics Students. *Procedia Social and Behavioral Sciences*, *12*, 600-614. https://doi.org/10.1016/j.sbspro.2011.02.074

Anam, R. S., Widodo, A., Sopandi, W. & Wu, H. (2019). Developing a Five-Tier Diagnostic Test to Identify Students' Misconceptions in Science: An Example of the Heat Transfer Concepts. *Ilkogretim Online,* 1014-1029. https://doi.org/10.17051/ilkonline.2019.609690

Arikunto, S. (2013). *Prosedur Penelitian: Suatu Pendekatan Praktik*. Jakarta: Rineka Cipta

Artiawati, P. R., Muliyani, R. & Kurniawan, Y. (2018). Identifikasi Kuantitas Siswa yang Miskonsepsi Menggunakan Three Tier-Test Pada Materi Gerak Lurus Berubah Beraturan (GLBB). *JIPF (Jurnal Ilmu Pendidikan Fisika)*, *3*(1), 5-7. https://dx.doi.org/10.26737/jipf.v3i1.331

Fakhruddin, Azizahwati & Yelfi, R. (2012). Analisis Penyebab Miskonsepsi Siswa Pada Pelajaran Fisika Di Kelas Xii Sma/Ma Kota Duri. *Jurnal Pendidikan Matematika*, *3*(1), 87-98. http://dx.doi.org/10.36709/jpm.v3i1.1988

Hermita, N., Suhandi, A., Syaodih, E., Samsudin, A., Isjoni, Johan, H., Rosa, F., Setyaningsih, R., Sapriadil & Safitri, D. (2017). Constructing and Implementing a Four Tier Test about Static Electricity to Diagnose Pre-service Elementary School Teacher' Misconceptions. *Journal of Physics: Conference Series*, *895*(1), 1-6. https://doi.org/10.1088/1742-6596/895/1/012167

Hidayatullah. (2022). *Pengembangan Instrumen Five-Tier Multiple Choice pada Materi Gerak Lurus untuk Menilai Pemahaman Konsep Siswa SMA/MA Kelas X*. Doctoral dissertation, Universitas Negeri Padang.

Kirbulut, Z. D. & Geban, O. (2014). Using Three-Tier Diagnostic Test to Assess Students' Misconceptions of States of Matter. *Eurasia Journal of Mathematics, Science & Technology Education*, 10(5), 509–521. https://doi.org/10.12973/eurasia.2014.1128a

Mosik, P. Maulana. (2010). Usaha Mengurangi Terjadinya Miskonsepsi Fisika melalui Pembelajaran dengan Pendekatan Konflik Kognitif. *Jurnal Pendidikan Fisika Indonesia*, 6(2), 98-103. Retrieved from https://journal.unnes.ac.id/nju/index.php/JPFI/article/download/1120/1035.

Mufit, F., & A. Fauzan. (2019). *Model Pembelajaran Berbasis Konflik Kognitif (Pbkk). Disertai Penerapan Untuk Remediasi Miskonsepsi Pada Sains Dan Matematika*. Malang: CV. IRDH.

Mufit, F., Festiyed, F., A. Fauzan, & Lufri, L. (2019). The Application Of Real Experiments Video Analysis In The CCBL Model To Remediate The Misconceptions About Motion's Concept'. *IOP Conf. Series: Journal Of Physics*, *1317*(1), 012156. https://doi.org/10.1088/1742-6596/1317/1/012156

Mufit, F., Asrizal, & Puspitasari, R. (2020). Meta-Analysis of the Effect of Cognitive Conflict on Physics Learning. *Jurnal Penelitian dan Pengembangan Pendidikan Fisika*, 6(2), 267-274. https://doi.org/10.21009/1.06213

Mufit, F., & Capriconia, J. (2022). Analysis of Concept Understanding and Students' Attitudes towards Learning Physics in Material of Straight Motion. *Jurnal Penelitian Pendidikan IPA*, *8*(3), 1453–1461. https://doi.org/10.29303/jppipa.v8i3.1381

Mufit, F., Festiyed, F., & Dirman, H. M. (2022). Review and Comparison of Four-Tier Multiple Choice and Five-Tier Multiple Choice Diagnostic Tests to Identify Mastery of Physics Concepts. *Jurnal Penelitian Pendidikan IPA*, *8*(1), 1–12. https://doi.org/10.29303/jppipa.v8i1.838

Mundilarto. (2010). *Penilaian Hasil Belajar Fisika*. Yogyakarta: Pusat Pengembangan Instruktional Sains.

Rahayu, P., & Hariyono, E. (2019). Profil Penguasaan Konsep Siswa pada Sub Materi Gerak Jatuh Bebas dengan Menggunakan Four Tier Diagnostic Test. *Inovasi Pendidikan Fisika*, 8(2), 618-622. Retrieved from https://jurnal.unesa.ac.id/index.php/inovasipendidikan-fisika/article/view/27791

Rohmah, Z. & Handhika, J. (2018). *Two-Tier Test* Diagnostik sebagai Identifikasi Miskonsepsi Tahap Awal Materi Kinematika Gerak Lurus Siswa Kelas X SMA MAN 1 Kota Madiun. *Quantum: Seminar Nasional Fisika, Dan Pendidikan Fisika*, 552-556. Retrieved from http://seminar.uad.ac.id/index.php/quantum/article/view/312

Rosita, I., Liliawati, W. & Samsudin, A. (2020). Pengembangan *Instrumen Five-Tier Newton's Laws Test* (5TNLT) Untuk Mengidentifikasi Miskonsepsi dan Penyebab Miskonsepsi Siswa. *Jurnal Pendidikan*

Fisika dan Teknologi (JPFT), 6(2), 297-306. http://dx.doi.org/10.29303/jpft.v6i2.2018

Saehana, S., Darsikin, Haeruddin & Kasim, S. (2020). Developing a Computer Simulation to Minimize Misconception in Motion Concept. *Journal of Physics: Conference Series*, *1422*(1), 012009. http://dx.doi.org/10.1088/1742-6596/1422/1/012009

Setiawati, W. E. & Jatmiko, B. (2018). Penerapan Model Pembelajaran Inkuiri Terbimbing Untuk Meningkatkan Pemahaman Konsep Fisika Siswa SMA. *Inovasi Pendidikan Fisika*, *7(2),* 287–291. Retrieved from: https://ejournal.unesa.ac.id/index.php/inovasi-pendidikan-fisika/article/view/24235/22161

Shalihah, A., Mulhayayiah, D., & Alatas, F. (2016). Identifikasi Miskonsepsi Menggunakan Tes Diagnostik Three-Tier Pada Hukum Newton Dan Penerapannya. *Journal of Teaching and Learning Physics*, *1(1)*, 24–33. Retrieved from https://journal.uinsgd.ac.id/index.php/jtlp/article/view/3438/2127

Suparno, P. (2013). *Miskonsepsi Dan Perubahan Konsep dalam Pendidikan Fisika*. Jakarta: Grasindo

Suwarto. (2013). *Pengembangan Tes Diagnostik dalam Pembelajaran*. Yogyakarta: Pustaka Pelajar.

Tarisalia, F. S., Irawan, I. D. A., & Fis, T. N. (2020). Studi Pustaka Miskonsepsi Siswa dalam Konsep Gerak Lurus, Gerak Parabola, dan Gerak Melingkar. *Jurnal Kependidikan Betara*, 1(4), 208-217.

Wahyuningsih, Raharjo, & Masithoh. (2013). Pembuatan Instrumen Tes Diagnostik Fisika SMA Kelas XI. *Jurnal Pendidikan Fisika,* 1(1), 111-117. Retrieved from https://jurnal.fkip.uns.ac.id/index.php/pfisika/article/view/1785

Yolanda, Y. (2017). Remediasi Miskonsepsi Kinematika Gerak Lurus dengan Pendekatan STAD. *SPEJ (Science and Physic Education Journal)*, *1*(1), 39-48. https://doi.org/10.31539/spej.v1i1.76