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Description Students' Misconceptions about the Concept of Motion in Sambas: Post Covid-19

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ABSTRACT
This study aims to provide an overview of the misconceptions of 10th-grade high school students in the Sambas district on the concept of motion during a pandemic which is an evaluation of the teaching and learning process of physics during the pandemic (Covid-19). The method used in this study is a survey method with descriptive data analysis with the subject or sample in this study of as many as 223 10th-grade students, consisting of 4 schools with cluster sampling. Based on the data analysis, it can be concluded that the students' misconceptions are still experiencing confusion. If two objects have the same position, they should have the same velocity; and if the two objects have the same velocity, the student assumed that these two objects must have the same acceleration or vice versa. However, students are able to distinguish which ones are scalar quantities and which are vector quantities. As for impetus material, students assume that if an object has a motion, it must have a force acting upon this object. This is a contradiction with newton's first law. Also, it is believed that if the object moves in a circular path, a circular (impetus) force tends to move this object in its path. The highest misconception is in the concept of kinematic about velocity-position and concept of impetus. There is no different in student misconception before and after pandemic covid-19 so that in the future it still needs to improve physisc learning process and physics teacher competence to prevention student misconception.

Keywords: *misconception, motion, post-covid19*

INTRODUCTION

The main purpose of physics learning carried out in schools and universities is for students to experience behavioral changes (Taqwa et al., 2015) and be able to master the main ideas, principles, laws, or physics concepts broadly and deeply (Sutopo, 2014). A good understanding of physics concepts can help students in solving problems in everyday life and problems in textbooks correctly (Maloney, 1994). Likewise, in explaining the phenomena of classical and modern physics, the ability to understand physics concepts is needed by students. Thus if students already have a very good understanding of concepts, students are able to solve physics problems.

Many findings from teachers and researchers found that student ability to understand physics concepts was still low, including students' understanding of motion concepts. This is indicated by the low concept understanding score as well as the ability to explain various physical phenomena which are still often wrong. Students' mistakes in explaining various physical

phenomena are often seen as misconceptions. Quoting from Brown (Suparno, 2013)states that a misconception is a wrong explanation and an idea that is not in accordance with the scientific understanding accepted by scientists.

Misconceptions are a phenomenon that until now have become a scourge in physics learning because their existence is believed to hinder the process of assimilation (transfer) of new knowledge in the minds of students (Tayubi, 2005). Misconceptions are strongly suspected to be formed because of experiences that occur in everyday life that have been experienced by students, as a result of these experiences they form concepts that are not necessarily the same as the concepts possessed by scientists. In addition, misconceptions also occur not only because students do not have any knowledge at all, but more because students are not able to activate knowledge that is relevant to the problems they face (Hammer, 2000). On the other hand, students' failure to solve physics problems is also caused by students not having a complete understanding and are still fragmented. When working on a physics problem it will be difficult for students to be able to relate it to previous physics knowledge, as we know that in physics one knowledge is interrelated with other knowledge. As a result, the use of knowledge possessed still depends on the context of the problems that arise.

(Yolanda, 2017) has classified several causes of misconceptions in students including (1) Students digesting and gaining knowledge without any correct concept justification from the teacher. (2) Teachers who do not master the concept tend to teach the wrong concept. (3) Communication Language that is difficult to understand in books tends to lead to misinterpretations from students so that students are only able to capture part or even not understand the concept at all. (4) Context, which consists of students' experiences, different everyday languages, friends others or wrong discussion partners, and wrong explanations by parents/others, all of which can lead to misconceptions. Thus misconceptions can occur not only because of the students themselves but can be caused by various things. Differences in culture, habits, learning styles, teaching, and times can also be the cause of misconceptions. Thus, if students' misconceptions continue to occur persistently, it can eventually hinder their ability to develop correct and sustainable knowledge. Knowledge will be limited to what they receive. Students' creativity in utilizing knowledge will be hampered.

In Indonesian curriculum of education, Elementry students have been introduced to simple physics knowledge that they often encounter in everyday life. One of them is about the concept of kinematic. They learn about the concepts of motion and distance, time and speed, as well as linear and circular motion, albeit in a simple manner, using examples of motion that they often observe in everyday life, for example the distance of their house to school, the speed of the bicycle/motorcycle/car and so on. In the learning process the concept/knowledge is taught through a scientific approach at all levels of education (elementary school, junior high school and senior high school) in Indonesia. Through this scientific approach students are taught how a scientist discovers a concept to develop critical, creative and innovative thinking skills through the scientific method. However, students' misconceptions regarding the concept of motion still occur, and many students still have misconceptions about this material. As stated by (Sutrisno, 2019), (Demirci, 2005) and (Pujianto, 2013) students from elementary to high school levels mostly experience misconceptions on kinematics of straight motion with moderate to high levels.

Researchers has shown that misconceptions often occur due to difficult and complex concepts, shallow understanding of students, or poor learning experiences of students, such as in the concept of motion studied by students from elementary, junior high school, and senior high school (Sari et al., 2019; Türker, 2005). (Widiyatmoko & Shimizu, 2018) showed that 10th grade students have various misconceptions in the concept of motion. Some common misconceptions include incorrect understanding of the equations of linear motion, the difference between

velocity and acceleration, and the relationship between time and distance. In addition, it was found that factors such as a lack of practical experience and inadequate teaching also contribute to the development of misconceptions.

The pandemic (Covid-19) has existed for more than 3 years, where this pandemic has gone global and affected various important aspects of life. Everyone is forced to stay at home and not get involved in crowd activities. One of the areas that has felt the most impact from COVID-19 is education. Especially education in Indonesia, to deal with the COVID-19 pandemic, the Indonesian government has swiftly issued Circular Letter Number 4 of 2020 regarding the implementation of education policies during the pandemic. One of them is the learning process that before the pandemic was implemented in classrooms (offline) and during the pandemic was implemented online (video conferencing, e-learning, and ect) (Anugrahana, 2020). However, in practice, teaching staff and students do not yet have mature readiness to learn online (Dewi, 2020). Online learning seems only to fulfill the educational process, but the essence of learning itself is not obtained by students. Control over students' attitudes and skills is difficult to do by teachers. Assessment is limited to student activities and assignments.

Starting from this rationale, this research has strategic value because it aims to provide an overview of the misconceptions of 10th-grade high school students on the concept of motion during the pandemic (Covid-19). Thus, it can be said that this research is one of the evaluations of the teaching and learning process of physics in a pandemic that has been almost 3 years in school. In addition, to add insight both for lecturers, educators (teachers), students, and stakeholders to take action and improve (reform) education, especially teaching physics after the pandemic. To describe the number of students who experience misconceptions about the concept of motion (kinematics and momentum) the researcher uses the FCI (force concept inventory) instrument which has been translated into Indonesian and has been validated by several experts including English lecturers and physics education lecturers and physics teachers at Senior High School..

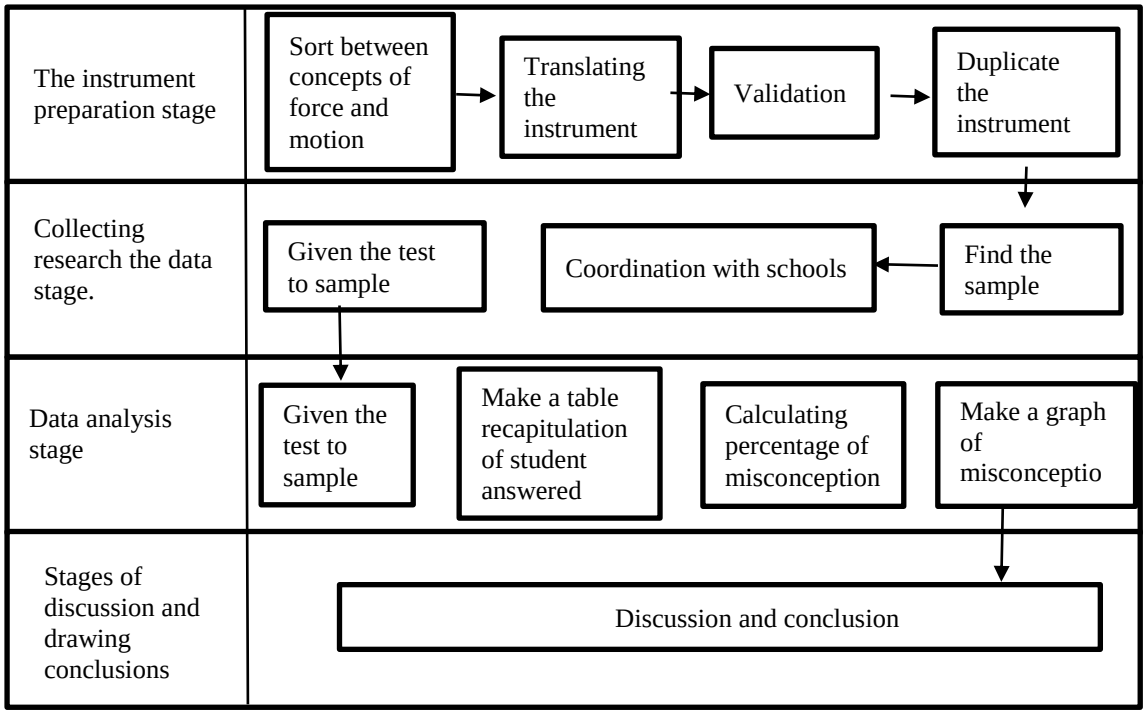
METHODOLOGY

The research method used in this study is a survey method with descriptive data analysis because this study aims to find out the misconceptions about the concept of motion of high school students in Sambas. Where the subjects or samples in this study were 220 students grade-10th, consisting of 4 schools from 4 different sub-districts with the selection of samples by cluster sampling. In addition, this study has 4 stages including preparation of instruments, research data collection, data analysis, and discussion and drawing conclusions. Broadly speaking, the three stages are as follows:

1. The instrument preparation stage. The purpose of this stage is to prepare the instrument used to achieve the research objectives so that researchers can describe and classify the types of student misconceptions about the concept of motion. At this stage, the researcher uses and adapts the FCI (force Concept Inventory) instrument that has been compiled by Hestenes in 1992. Because this instrument consists of the concepts of force and motion and is still in English, at this stage the researcher will: (a) sort between concepts of force and motion, (b) translate the instrument into Indonesian, (c) construct validation given to 5 experts (lecturers and physics teachers), and (d) duplicate the instrument
2. The stage of collecting research data. At this stage, the researcher selects and determines the sample using random sampling, then coordinates with the school, and finally gives a test.
3. Data analysis stage. After students fill in the research instrument given, the next step is the analysis of research data. Where at this stage the researcher grouped student answers, made a

recapitulation table of student answers, calculated the percentage of each misconception, class, and school, and made a graph of the results of the analysis.

4. Stages of discussion and drawing conclusions. This stage is the last stage of the research. Where after the data is analyzed, the next step is to discuss the findings obtained from data analysis and then draw conclusions.



For more details, the stages of the research can be seen in the flow chart below.

RESULT AND DISCUSSION

In the curriculum, the concept of motion is taught starting from elementary school, where students at all levels of education are taught critical, creative, and innovative thinking skills through scientific methods in learning motion in physics. The science curriculum, especially physics subjects, also emphasizes the importance of practicum or experimental activities to develop students' skills in observation, measurement, and data analysis. Through practicum activities students can be directly involved in the process of finding concepts or knowledge like a scientist discovering these concepts. However, all of these curriculum policies were forced to change since the pandemic hit Indonesia, causing the school curriculum, especially in physics, to change into an "emergency curriculum" where for three years the learning process was carried out virtually, students could not carry out practicums and experiments in physics subjects and student achievements were measured through assignments and tests conducted at the end of the semester

Before the mass pandemic hit the world, researchers had a lot of interest in exploring students' misconceptions about the concept of force and motion at various levels of education (such as (Resbiantoro & Nugraha, 2017; Sutrisno, 2019; Wiyono et al., 2016). Just like in the concepts of displacement and distance, velocity and speed, acceleration, linear motion with constant acceleration (GLB) and linear motion with varying acceleration (GLBB), and ect. Then at the end of 2019, the COVID-19 pandemic hit the world, and had a huge impact on the learning system especially in Indonesia. One of the biggest changes in learning situation is the change in teaching and learning class, which was originally in the classroom (offline), and turned into a virtual classroom (Nafrin & Hudaidah, 2021). Based on the survey results of the Ministry

of Education and Culture Indoensia in 2020, the teaching method that is often done by teachers during the pandemic only gives assignments in the form of questions to students. So (Siahaan, 2020) with learning like that makes students feel bored, bad time, lack focus and are stressed because they sit in front of a computer (laptop) or handphone for too long.

This study aims to provide an overview of students' misconceptions which is a reflection and evaluation of online learning during the pandemic. This research can be used as a guideline for future improvements in the process of recovery the educational process after the pandemic. Student misconceptions can be described using FCI instruments that have been translated, sorted, and validated. The FCI instrument is an instrument or multiple-choice test designed to see students' understanding of the concepts of force and motion (Savinainen & Scott, 2002). Furthermore, (Hestenes et al., 1992) also mention that FCI can also provide a clear and detailed picture of misconceptions in physics. The Misconception Indicator in FCI consists of 6 concepts including 1). Kinematics; 2). Impetus; 3). Active Force; 4). Action/ Reaction Pairs; 5) Concatenation of Influences; 6). Other Influences on motions (Savinainen & Scott, 2002).

Because the purpose of this study was to describe how big 10th grade senior high school students' misconceptions about the concept of motion, this study only uses several numbers of FCI instruments related to the concept of motion, other unrelated concepts were not used. Thus, the selected FCI instruments about motion are questions that can identify students' misconceptions about kinematics and impulse concepts. This FCL instrument as shown in Table 1. The concept of kinematics is related to the concepts of position, velocity, acceleration, vector and non-vector in the motion of objects. The concept of impetus is associated with the movement of objects caused by a force acting on the object, and this concept is contrary to Newton's first law, as well as the impetus that occurs when an object moves in a linear motion and in a circular motion.

Table 1. FCL Instrumen in Kinematic and Impetus Concepts

Misconception	Descriptions	Related FCI Questions and distractors
1. Kinematics		
a. Confusion between position and velocity.	Confusion about an object's position or velocity. If two objects have the same position. They should have the same velocity	24-choices B, C, And D
b. Confusion between velocity and acceleration.	Confusion about an object's velocity and acceleration. If the two objects have the same velocity. It is assumed that these two objects must have the same acceleration or vice versa	24-choice A; 25-choices B and C
c. Confusion between vector and non-vector velocity composition	Confusion about vector composition. For example, velocity composition	11- choice C
2. Impetus view		
a. Impetus supplied by "hit"	If an object has a motion, it must have a force acting upon this object. This is a contradiction with newton's first law. Also, it is believed that if the object moves in a circular path, a circular (impetus) force tends to move this object in its path.	26-choices B, C, and E; 13-choices B and C; and 33-choice D.
b. Lose and recovery of the original impetus		30-Choices A, D, and E; 8-choice D; 28-choice A; 10-choices C and E; and 33-Choice A
c. Impetus dissipation		9-choices A, B, and C; 12-choice C; 20-choices C and D; 27-choice E; 31-choices C and E; and 33-choice B.
		10 & 28-Choice D; 12-Choices B and D; 33-Choice E

d. Delay impetus build-up	8-choice A and D; and 14-Choice A
e. Circular impetus	

Hestenest (1992) and Demirci (2005)

The results of the identification of students' misconceptions 10 on the concept of motion is presented in Figure 1. Diagram of the identification of students' misconceptions for each concept.

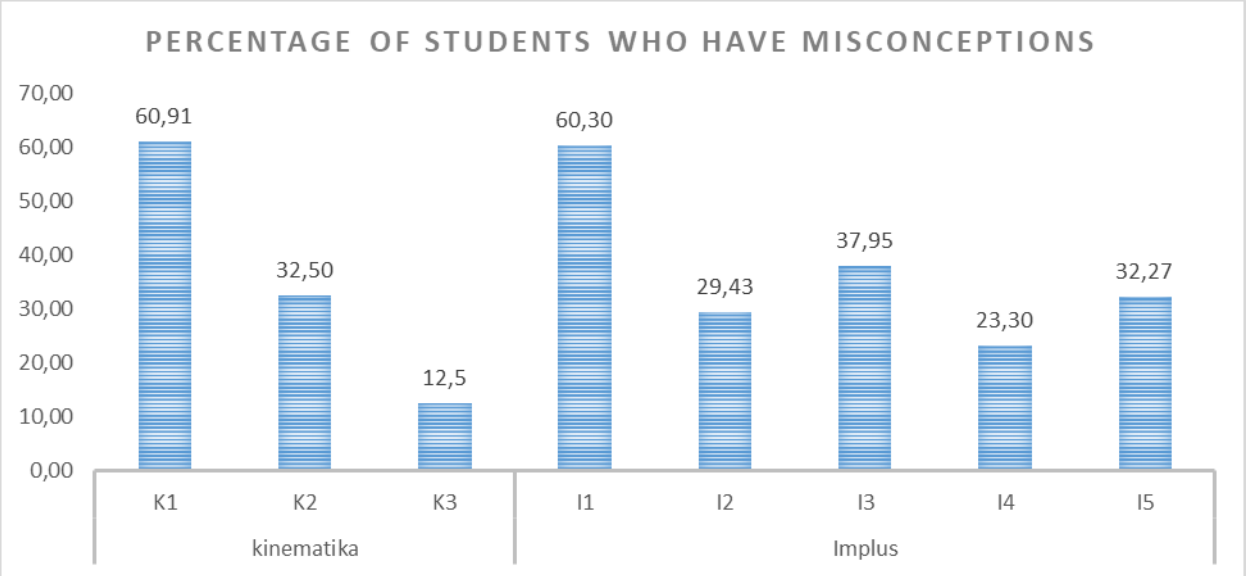


Figure 1. Graph of students' misconceptions the concept of motion

The misconception is a wrong explanation and an idea that is not in accordance with the scientific understanding accepted by scientists (Suparno, 2013). Based on Figure 1, the most common misconceptions about the concept of motion are first the kinematics topic is the concept of position-velocity indiscriminately (60.91%), the concept of velocity-acceleration indiscriminately (32.50%), and the concept of non-vectorial velocity composition (12.5%); and the second topic is impetus supplied by "hit". ” (60.30%), impetus dissipation (37.95%), circular impetus (32.27%), loss/recovery of original impetus 29.43%, and gradual/delayed impetus build up.

The misconception that is classified as high for 10th Senior Hight School Students in Sambas district is on the concept of position-velocity, where around 60.91% of the sample thinks that if two objects have the same position, they must have the same velocity. Even though position does not determine the velocity of the object, position only determines the location (ordinate) of the object in a path after making a movement from a certain reference (axis). Meanwhile, velocity is a quantity that indicates how fast an object moves relative to a certain reference. Although position and velocity are both vector compositions. Misconception about confusion between velocity and acceleration around 32.50% Senior high school students in Sambas believe that objects moving at the same speed have different accelerations. Different accelerations of objects will result in objects having different final velocity, as we know that positive acceleration is an increase in object velocity per unit time, as well as for negative acceleration, namely a reduction in the velocity of objects velocity per unit time. However, there are also a number of misconceptions with the smallest percentage which is around 12.5% for the concept of vector composition or scale, such as velocity is vector composition. This means that students are able to distinguish which ones are vector compositions and which are scalar compositions in motion concept. Such as: position, velocity, and acceleration in motion concept.

In addition, in impetus concepts, 60.30% of the sample also assumes that an object can move because there is a force acting on the object along its path. This is contradiction with Newton's first law which states that a moving object will continue to move provided that there is no external force acting on the object, as well as a stationary object will remain stationary provided that there is no external force acting on it. We can make an example a table will not move its position, will always be in the same position if there is no external force acting on the table. A car that is moving, will always move and will not stop or slow down if there is no external force acting on the car. That why newton's law is said to be the law of inertia or the law of laziness. Every object is naturally lazy to change, the only one that ca makes it change is an external force. Although in general "visible" objects move because they are given an impetus, but what about the coconuts that fall from the tree, the coconuts are not given an impetus but gravity plays its role on the mass of the coconuts that are above the tree. Meaning that impetus does not always cause objects to move, there are other forces acting on an object that cause it to move, and these forces are not always "impetus". Based on newton's first law impetus can also cause objects not move or slow down its movement on condition that the direction of the given impetus is opposite to the direction of the object's motion. For example, the process of braking a car, friction between car tires and the road, friction between shoes and the floor when wearer walking, friction between table and the floor when we move it. Several studies before the pandemic also found the same thing, namely misconceptions about kinematics and thrust material at a higher level compared to misconceptions about other concepts (Bayraktar, 2009; Galili & Bar, 1992; Rahmawati et al., 2020). This is also supported by (Azman et al., 2013) misconception on Newton's first law is the highest compared to the other two, 86.19% prospective physics teachers in UPSI show misconception. This indicates that misconceptions about the concept of motion did not experience significant changes through the learning process before and after the covid 19 pandemic.

This is still related to the next misconception indicator regarding impulse dissipation, where 37.95% of grade 10 high school students experience misconceptions on this concept. They believe that releasing an impulse on a "moving object" will automatically cause the object to come to a stop. For example, in question number 5, which describes a scenario where a boy throws a ball upwards, most students answer that "the upward force decreases until reaching maximum height and the gravitational force increases until approaching the ground." However, in reality, only the gravitational force acts on the ball. We can assume that students do not truly understand what will happen when multiple forces are applied to a moving object. They assume that when an object is in motion, a force must be applied in the direction of the object's motion (Poutot & Blandin, 2015). In physics, impulse cannot dissipate instantly unless the object encounters another force in the opposite direction to the applied force (Kozhevnikov & Hegarty, 2001). Examples of such forces include floor friction, road friction, air resistance, and ect.

The magnitude of the misconceptions experienced by students for the style concept shown in the graph above is due to several things, namely: 1) the conception built by the environment around students (Matthews et al., 2005; Suparno, 2013; Yolanda, 2017); 2) changes/conceptual transfers that occur in the classroom include errors from students in digesting conceptual information as a piece of theory (DiSessa, 1988; Sherin, 2006); 3) language that is difficult to understand and digest, and conceptual errors conveyed by the teacher (Yolanda, 2016). Based on this research data, further research can be implemented to know factors that cause students' misconceptions and doing some action in learning process to prevention this misconception. To reduce student misconception in physics concept can do with some basic rule: 1) the rule of completeness of information; 2) the knowledge about related ideas; 3) the existence of entire trains of thought about concept; 4) thorough knowledge of the basic principles of physics (Kuczmann, 2017).

CONCLUSION

Based on the analysis of the FCI instrument that has been given to students in 10th grade at the Sambas district, it can be concluded that students' misconceptions about the concept of motion during the pandemic mass are in each of the misconception indicators of the FCI instrument. For the concept of kinematics, students still experience confusion If two objects have the same position, they should have the same velocity; and If the two objects have the same velocity, It is assumed that these two objects must have the same acceleration or vice versa. However, students are able to distinguish which ones are scalar quantities and which are vector quantities. As for impetus material, students assume that if an object has a motion, it must have a force acting upon this object. This is a contradiction with newton's first law. Also, it is believed that if the object moves in a circular path, a circular (impetus) force tends to move this object in its path. This indicates that misconceptions about the concept of motion did not experience significant changes through the learning process before and after using "emergency curriculum" at covid 19 pandemic.

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