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Systematic Review of Misconceptions in Kinematics: Identification, Causes, and Remediation

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Abstract: The purpose of this study was to find out the topics that become students' misconceptions in kinematics, the causes that can trigger misconceptions, and the remediation used to overcome these misconceptions. The method used in this research was the systematic review method. Based on the data analysis, it was found that the biggest misconception among students was in straight motion. Several causes trigger the emergence of misconceptions in kinematics, where the causes that often arise come from the students themselves, namely, students' preconceptions or initial conceptions, students' abilities, students' cognitive development stages, wrong intuitions, and students' reasoning. The remediation that was often used to remediate misconceptions was the use of learning models, for instance, generative models.

Keywords: Causes; kinematics of motion; misconceptions; remediation.

Introduction

The term misconception is usually used to mention a discrepancy with the actual scientific concept, misconceptions can be caused by many things such as daily experiences when interacting with the surrounding nature, internal factors that arise in students or teachers, errors in teaching materials, and even inappropriate learning methods (Suparno, 2005). Misconception or misconception is a phenomenon that until now has become a scourge in teaching physics and other sciences because its existence is believed to hinder the assimilation process of new knowledge in the minds of students. Nurulwati et al., (2014) classify physics misconceptions into five types, namely Preconceived notions, nonscientific beliefs, conceptual misunderstandings, vernacular misconceptions, and factual misconceptions. One that often arises in the physics learning process is conceptual misunderstanding, which means conceptual misunderstanding, which can be caused by the initial conceptual understanding brought by students before they get through school learning which is usually influenced by the surrounding environment.

Before studying physics material, all students certainly already have experience with physics events in everyday life, for example in free-falling objects, energy electricity flow, collisions, and others. With that experience then in the minds of students already formed an intuition and "student theory" about the events of physics, intuition, and theory formed is not necessarily true. If intuition is wrong then in the future it will be difficult to fix, because unintentionally has been consistently wrong physics concepts will be his life guide (Tayubi, 2005). The existence of misconceptions will greatly hamper the process of receiving and simulating new knowledge in students so it will hinder the success of students in the learning process further (Klammer, 1998). This is a very big problem in physics learning which certainly cannot be allowed.

Physics is a branch of science that studies objects in nature physically and written mathematically so that they can be understood by humans and utilized for the welfare of mankind (Sunajem, 2012) . Based on this, physics learning cannot be separated from

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understanding concepts, applying them in solving physics problems and working scientifically (Hoellwarth et al., 2005). One aspect that must be considered in physics learning is concept understanding. The importance of concept understanding in physics learning can be seen in the first objective of physics learning. That is to understand what concepts are contained in physics. A person's understanding of a concept is called a conception, while errors in understanding concepts that are not by the agreement of scientists are called misconceptions.

Many misconceptions occur in the field of physics, especially mechanics (Suparno, 2005). One of the mechanics materials studied at the high school level is kinematics. Kinematics of motion consists of several material topics including straight motion, parabolic motion, free fall motion, and circular motion, in each sub-topic there are many misconceptions. This is supported by several previous studies that show misconceptions on the topic of parabolic motion. The form of misconception in parabolic motion is that students assume that a ball thrown from any direction will form a certain angle to produce a parabolic trajectory (Mufit et al., 2019). Furthermore, on the topic of straight motion, many students have difficulty distinguishing between distance and displacement (Nana, 2020).

In addition, based on research conducted by Yolanda (2017) through direct observation it was found that the lack of interest in learning students in physics resulted in misconceptions in free fall motion material, namely, students think that when falling freely, objects with heavier masses are faster than objects with lighter masses. In a study conducted by (Rosita et al., 2013), it was found that student learning outcomes were quite low in circular motion material, this was due to the misconceptions that occurred in circular motion material, namely, students could not distinguish between frequency and period formulas where students were reversed in using these formulas.

Misconceptions that occur in students are inseparable from the causes or sources of conceptual discrepancies. The causes of misconceptions can be caused by several sources, namely from students, teachers, textbooks used, context, and the way teachers teach (Suparno, 2013). Several factors cause misconceptions in students, including the wrong initial concept, the stage of cognitive development not by the concepts learned, limited and incorrect student reasoning, the ability of students to capture and understand the concepts learned, and the lack of student interest in learning the concepts given and taught (Dwi et al.,2014). Misconceptions can also occur due to errors in teaching materials, written errors will be easily digested by students and thus they acquire misconceptions (DiFonzo & Bordia, 1998). Misconceptions can occur in school or outside of school, misconceptions in students are caused by errors in the perception of emerging concepts, confusion between impressions and memories that already exist in the brain during remembering, not checking the truth of the generalizations obtained, or being too sure of the results of one observation or conceptual thinking (Setiawati et al., 2014). In the physics learning process, teachers often find that not all physics concepts taught can be understood by students correctly. Students often misunderstand a concept fully and deeply, and this can certainly cause misconceptions in students.

Several steps can be taken to help overcome misconceptions, namely finding or revealing misconceptions made by students, trying to find the cause of misconceptions, and finding appropriate treatment to overcome misconceptions (Suparno, 2013). Therefore, it is necessary to have appropriate actions or activities to improve students' conceptions, this improvement activity is called remediation activities. Remediation can be interpreted as an activity that aims to improve the less successful learning process (Sutrisno et al., 2019). Sutrisno et al., (2019) added that remediation will be effective if it can understand the nature of difficulties, know exactly the factors that cause them and find various ways to overcome difficulties that are relevant to the factors that cause them. Remediation needs to be created by educators to change students' misconceptions through various strategies or learning models to reduce misconceptions that occur in students (Mufit et al., 2019).

Based on many similar studies that have been conducted, there is a lot of information that discusses misconceptions, causes, and remediation in kinematics. Due to the large number of previous studies that discuss, it is necessary to review and analyze a study to summarize and synthesize the results of each of these studies systematically and thoroughly. The information obtained later will be useful for teachers to find out what misconceptions occur in kinematics, their causes, and how to remediate misconceptions in the material. Reviewing and analyzing thoroughly in a study can be done with the Systematic review method.

A systematic review can be defined by a specific method that locates existing studies, selects and evaluates contributions, analyzes and synthesizes data, and reports back evidence in such a way as to allow fairly clear conclusions to be reached about what is known and not known (Denyer et al., 2019). The systematic review is a very rigorous procedure in identifying, assessing, and synthesizing all relevant research results related to research questions, specific

topics, or phenomena of concern with strategies for limiting bias (Briner et al., 2009), as well as being the "Gold Standard" in assimilating and digesting research (Oxman et al., 1944). Systematic reviews also have one or more objectives such as: to integrate (compare and contrast) what has been done and said by others' research; to criticize previous scientific work; to build bridges between related topics areas, and; to identify key issues in a field (Hadi et al., 2020). Hadi et al., (2020) also added that the Systematic Review perspective can: present the findings naturally, as well as; support the position of theories, models, relationships, relationships, and conceptual frameworks from various fields of research.

Based on the above background, it is necessary to conduct a review with the Systematic Review method of misconceptions, causes and remediation efforts on kinematics, therefore a study was conducted with the title: "Systematic Review of Misconceptions in Kinematics: Identification, Causes, and Remediation".

Method

The method used in this research is the Systematic Review method. Systematic Review is a systematic way to collect, critically evaluate, integrate, and present findings from various research studies of research questions or topics of interest (Hadi et al., 2020), in other words, Systematic Review is a special methodology that places existing research, selects, and evaluates contributions, analyzes, and synthesizes data, and reports back evidence in such a way as to allow clear enough conclusions to be reached.

In this study, the data used is secondary data. According to (Sugiyono, 2019), secondary data is a source that does not directly provide data for data collection. Secondary data is data obtained from sources that can support research, including documentation and literature. Secondary data is data obtained not from direct observation, this data is obtained from the results of research that has been conducted by previous researchers, in this study the data was obtained through the article under study (Grant & Booth, 2009). The calculation carried out in this study is to calculate the percentage of misconceptions, causes of misconceptions, and remediation used to reduce misconceptions in kinematics, with the formula 1.

$$p = \frac{f}{N} x100\% \quad (1)$$

Description:
P = Percentage number
f = Frequency sought (number of articles in each category in the table)
N = Number of frequencies (articles used in each table)

This research uses three keywords, namely: misconceptions in kinematics, causes of misconceptions, and remediation used to reduce misconceptions. This research uses articles contained in national and international journals or proceedings. After searching to get the articles needed, the articles used are articles that meet the predetermined criteria. The articles used in the study are the latest articles published in accredited national journals and international journals or proceedings with a range of 2013-2023 (the last 10 years) and the article discusses misconceptions, causes, and remediation in kinematics. The article selection procedure can be seen in Figure 1.

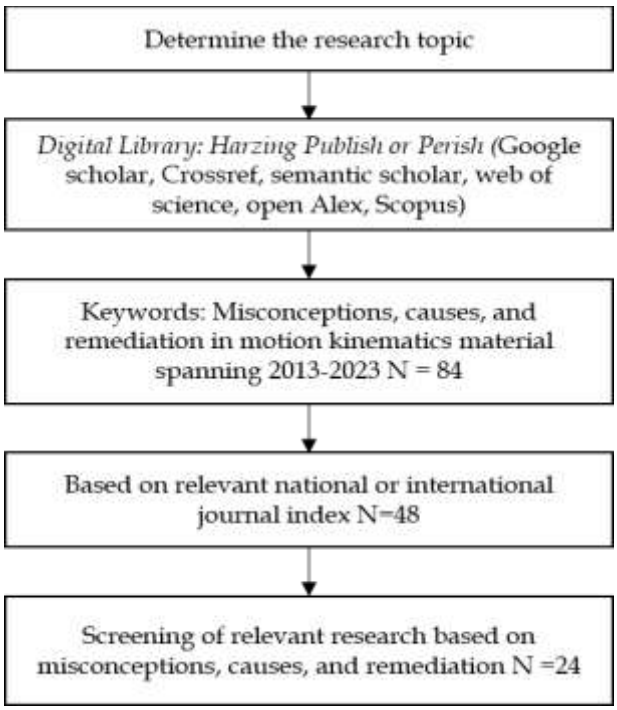

Figure 1. Manuscript Selection Process

Result and Discussion

The results of this study present the answers to the problem formulation that reviews articles on misconceptions, causes, and remediation of kinematics. The first research result shows the findings of articles in the range of 2013-2023. The second research result explains the topics that become students' misconceptions in kinematics. The third research result is the cause that triggers the emergence of misconceptions in the material and the fourth result explains the remediation used to reduce the misconceptions that occur on the topic of the material. The twenty-four articles examined in this study are

articles published in national and international indexed journals in the range of 2013-2023 (see details in Table 1).

Table 1. Article Findings in 2013-2023

Year	Article Code	Total	Percentage
2013	A13, A18, A23	3	13%
2014	A14	1	4%
2016	A3, A11, A17, A19, A22	5	20%
2017	A4, A15, A20, A21	4	16%
2018	A8, A9	2	8%
2019	A1, A2, A12, A16, A24	5	20%
2020	A5, A6	2	8%
2023	A7, A10	1	4%

Table 2. Misconceptions, Causes, and Remediation on the Topic of Kinematics

Topics	Article Code	Literature
Parabolic Motion	A1	(Mufit et al., 2019)
	A2	(Mufit, 2018)
	A3	(Syuhendri, 2016)
	A14	(Fauziah et al., 2014)
	A15	(Restu et al., 2016)
	A13	(Khoiruddin et al., 2017)
	A16	(Sutrisno et al., 2019)
Free Fall Motion	A4	(Yolanda, 2017)
	A8	(Rahayu, 2018)
	A9	(Aminah et al., 2018)
	A10	(Ayopma et al.,2023)
	A20	(Sutrisno et al., 2019)
	A21	(Muharna, 2017)
	A24	(Alie, 2013)
Straight Motion	A4	(Yolanda, 2017)
	A5	(Nana, 2020)
	A6	(Saputra, 2020)
	A7	(Ibnusaputra et al., 2023)
	A8	(Rahayu, 2018)
	A9	(Aminah et al., 2018)
	A11	(Sukariasih, 2016)
	A12	(Fauziah, 2014)
	A13	(Mukrima et al., 2016)
	A20	(Huda et al., 2016)
	A22	(Kamaludin et al., 2013)
	A23	(Alie, 2013)
Circular Motion	A17	(Firmansyah et al., 2016)
	A18	(Rosita et al., 2013)
	A19	(Pranita et al., 2016)

Based on Table 1, 24 articles reviewed in this study, the largest number of publications in kinematics was published in 2016 and 2019 (20%). Over the past 2 years, from 2013 to 2015, there has been a decrease in the number of articles discussing misconceptions in kinematics. There was an increase in 2016 and fell back in 2017 to 2018. In 2019 the number of articles increased but fell again in 2020 to 2023. The second result in this study is the topic of kinematics that has misconceptions followed by the causes of misconceptions that arise and remediation efforts used to overcome these misconceptions, which can be seen in Table 2.

What forms of misconceptions arise in kinematics?

Based on the analysis that has been carried out and presented in Table 2 above, 4 topics become students' misconceptions in kinematics. Topics that become misconceptions in kinematics, namely parabolic motion, free fall motion, straight motion, and regular circular motion. Each article can discuss more than one concept that becomes students' misconceptions in kinematics. The topic that often experiences misconceptions in kinematics is straight motion, out of 24 articles studied, where 12 articles discuss misconception findings on the concept of straight motion and the topic that experiences the least misconceptions is circular motion where 3 articles discuss these misconceptions from 24 articles studied.

Based on the data analysis that has been done, 6 forms of misconceptions occur in parabolic motion material hats. The form misconception that often arises is that students assume that the ball is the same as the y-axis (vertical) thrown from various directions will form a certain angle to produce a parabolic trajectory (Mufit et al., 2019; Mufit, 2018), this is evident because 2 articles discuss these misconceptions. According to Lestari (2009), if the ball is thrown horizontally then the object will experience straight horizontal motion, if the ball is thrown up then the ball will experience straight vertical motion and if the ball is thrown at an angle then the object will move with a curved trajectory or parabolic trajectory. Therefore, the ball will form a certain angle and produce a parabolic trajectory based on the shape or direction of the throw.

The forms of misconceptions on the topic of free fall motion material are: Students think that the concept of free fall motion is only influenced by initial velocity (Aminah, 2018; Yolanda, 2017); students think that during free fall, objects with a larger mass fall faster than objects with a smaller mass (Ayopma, 2023; Muharna, 2017; Rahayu, 2018); students think that in a vacuum when two objects with different masses are dropped together at the same height, then objects with a larger mass fall faster than objects with a smaller mass. (Muharna, 2017); students assume that in a vacuum when two objects with different masses are dropped together at the same height, the object with the larger mass will reach the bottom first (Alie, 2013; Sutrisno et al., 2019). Of the three forms of misconceptions that occur, the misconception that often arises is that students think that in free fall, objects with larger masses

will fall faster than objects with smaller masses (Ayopma et al ., 2023; Muharna, 2017; Rahayu, 2018). The correct concept in this form of misconception is that the length of time an object falls freely is influenced by gravity and height while the mass and type of material forming it have no effect (Giancoli, 2001). So, the speed of free-falling objects is not influenced by the size or mass of the object but can be influenced by gravity and altitude.

The topic of straight motion is one of the topics in kinematics that discusses the most misconceptions. The forms of misconceptions that occur on the topic of straight motion material are: students assume that velocity is the same as speed (Aminah et al., 2018; Kamaludin, 2013; Sutrisno et al., 2019; Yolanda, 2017); students assume that distance is the same as displacement (Ibnusaputra et al., 2023; Indriastuti et al.,2022; Mukrimaa et al., 2016; Nana, 2020; Saputra, 2020; Sukariasih, 2016); students assume that a large speed in a straight motion material is the same as displacement (Huda et al.,2016; Kamaludin, 2013); Students assume displacement and position are the same (Rusmini, 2016); students assume acceleration only has a large size (Indriastuti et al., 2022); students assume acceleration is the same as speed a=v (Indriastuti et al., 2022). Related to the analysis that has been carried out, the most common form of misconception is that students consider distance equal to displacement (Ibnusaputra et al., 2023; Indriastuti et al.,2022; Mukrima et al., 2016; Nana, 2020; Saputra, 2020; Sukariasih, 2016). The correct concept is that distance and displacement are different, distance is the length of the path traveled by an object in a certain time interval while displacement is the change in the position of an object in a certain time interval (Rusmini, 2007).

The last topic is circular motion, the forms of misconceptions that occur are: Students assume that motion in a circular trajectory with a fixed velocity is the same as motion in a circular trajectory with a fixed angular acceleration (Firmansyah & Wulandari, 2016; Juliani et al., 2021); students cannot distinguish between the period and frequency formulas where students are reversed in using the formula (Pranita, 2016; Rosita et al., 2013). The form of misconception that often arises is that students cannot distinguish between the period and frequency formulas where students are reversed in using the formula formula(Aini & Mufit, 2022; Ramadhanti et al., 2021). Where the formula for determining the amount of pride and frequency is different, to determine the period of circular motion is T = t / n with T = number of periods, t = time (s), and n = number of rounds (Chudinov, 2011).

What are the causes that trigger misconceptions in kinematics?

The existence of forms of misconceptions in kinematics is due to the causes that trigger these misconceptions. According to (Capriconia & Mufit, 2022; Thompson & Logue, 2006), there are several main factors causing misconceptions including students, teachers, textbooks, context, and teaching methods. The occurrence of misconceptions in students is caused by several factors, including preconceptions or initial concepts of students; associative thinking; humanistic thinking; incomplete reasoning; wrong intuition; stage of cognitive development; student ability; and interest in learning. Furthermore, the specific reasons that can arise from the teacher are: not mastering the material, incompetence; not having a background in physics; not inviting students to express ideas; poor teacher-student relations. The causes of misconceptions that can occur in textbooks are wrong explanation; wrong writing, especially in formulas; the difficulty level of the book is too high for students; students do not know how to read textbooks; science fiction books sometimes have distorted concepts; cartoons often contain misconceptions.

The next main cause is context, the causes of misconceptions that can occur through context are: student's experience; different daily language; wrong discussion partner; belief and religion; other people's wrong explanation; wrong context of student's life (TV, radio, movie); and feeling happy or not, free, or depressed. Furthermore, the last main cause is the teaching method because the specific causes that can arise from this teaching method are: only contains lectures and writing; directly into mathematical form; does not reveal students' misconceptions; does not correct wrong homework; analogy model; practicum model; discussion model; narrow demonstration model; non-multiple intelligence.

Based on the analysis that has been done on the topic of kinematics, the overall causes of misconceptions are Preconceptions or students' initial conceptions; Wrong intuition; learners' abilities; students' reasoning; stage of cognitive development; and learning process that only contains lectures and writing. Students' preconceptions or initial concepts before entering formal learning often contain errors that cause misconceptions to appear. These preconceptions are usually acquired by students from parents, friends, or early schooling, and experiences in their environment. These preconceptions show that children's minds since birth are not silent, but continue to be active to understand something (Fadllan, 2011). Another contributing factor is faulty intuition. Wrong intuition is a feeling in a person that spontaneously expresses his attitude or idea about

something before it is objectively and rationally scrutinized (Sari & Mufit, 2023). Meanwhile, according to (Entino et al., 2021), students' incomplete reasoning can also cause misconceptions. Incomplete reasoning can be caused by incomplete information received.

Another contributing factor to the emergence of misconceptions is the ability of students. This is evidenced by research conducted by Muharna (2017) which states that there are still many students who find it difficult to understand physics material because it takes a relatively long time to understand concepts due to the lack of student ability to learn physics material, especially in the topic of kinematics. The better the student's ability to understand a concept, the less likely the appearance of misconceptions. Furthermore, students' cognitive development that is not by the material being studied can also cause misconceptions. In general, students who are in the operational concrete stage will find it difficult to understand and often misunderstand something abstract (Dirman et al., 2022). The last cause in this study is the learning process that still uses the lecture and writing method so that it will result in students who tend to be bored and inactive during the learning process, this certainly triggers misconceptions in the students themselves.

What form of remediation is done to overcome misconceptions in kinematics?

Based on the analysis that has been carried out from 24 articles, there are various forms of remediation used to overcome misconceptions and remediation in kinematics. The forms of remediation carried out are presented in Table 3 and Table 4.

Table 3. The Use of Learning Models in Remediating Misconceptions

Learning Models	Article Code
Conceptual change model	A3
Guided inquiry learning	A5
Cognitive conflict strategy	A11
Demonstration	A12, A18
Discovery learning	A13
Problem posing learning model	A14
Metacognitive strategies	A15
Generative learning model	A17, A20
Reciprocal teaching model	A19
Cooperative learning type NHT	A24
Conflict-Based Learning	A1

Based on Table 3, there are 3 methods, 2 strategies, 9 learning models and 2 approaches that have been used to remediate misconceptions in kinematics. More learning models are found in remediating misconceptions in kinematics, of course, because of the many developments in learning models that have been carried out by previous researchers. In addition, learning models have standard stages and each model uses different stages or syntax (Mufit, 2020). Based on the data analysis found, the model that is often used is the generative learning model. By using the generative model, students' conceptions that are not by scientific concepts will be directed to be constructed with the facts owned by students to produce an appropriate conclusion that is by scientific concepts (Firmansyah et al., 2016). However, each method, strategy, learning model and approach has its uniqueness, and all of them still have the same goal, namely remediating misconceptions that occur in students so students can get a new knowledge. Kinematics learning should emphasize to conceptual understanding of students by implementing one of the method, strategy, or even learning model in physics learning (Sarkity & Sundari, 2020).

The next form of remediation is related to the media or teaching materials used in remediating students' misconceptions about kinematics. This is shown in Table 4.

Table 4. Use of Media or Teaching Materials in Remediating Misconceptions

Media or Teaching Materials	Article Code
Experimental video	A1, A2
Electronic worksheet based-Guided inquiry	A7
Interesting media	A9
Teaching materials	A10
Delay feedback with video tutorials	A13
Feedback by using brochures	A16
Graphic organizer	A15

The teaching media or materials used certainly have their advantages, the most widely used teaching media or materials are experimental videos. Video media has more capabilities because this media includes the sense of hearing and the sense of sight (Setyosari et al.,2005). Learning media with videos will be more likely to be easily remembered and understood. Based on research conducted by (Handhika et al., 2019)it was found that visual learning media can increase memory from 14% to 38%. This research also shows up to 200% improvement in vocabulary when taught with visuals. Even the time needed to convey concepts is reduced by 40% to increase verbal presentations (Purwanti, 2015). Through this experimental video, students also get real experience to conduct experiments, analyze graphs and find equations of motion like a scientist, and of course, students will feel that learning is easier and more fun for students (Mufit et al., 2019).

From the studies that have been reviewed, it is clear that the topic of material that often occurs misconceptions is the topic of straight motion material.

The forms of misconceptions that occur on the topic of straight motion material are: students assume that velocity is the same as speed (Aminah et al., 2018; Kamaludin, 2013; Sutrisno et al., 2019; Yolanda, 2017); students assume that distance is the same as displacement (Ibnusaputra et al., 2023; Indriastuti et al.,2022; Mukrima et al., 2016; Nana, 2020; Saputra, 2020; Sukariasih, 2016); students assume that a large velocity at a certain time has a large acceleration as well (Huda et al., 2016; Kamaludin, 2013); Students assume displacement and position are the same (Rusmini, 2016); students assume acceleration only has a large size (Indriastuti et al., 2022); students assume acceleration is the same as speed a=v (Indriastuti et al., 2022). Related to the analysis that has been carried out, the most common form of misconception is that students consider distance equal to displacement (Ibnusaputra et al., 2023; Indriastuti et al.,2022; Mukrima et al., 2016; Nana, 2020; Saputra, 2020; Sukariasih, 2016) . The correct concept is that distance and displacement are different. Distance is the length of the path traveled by an object in a certain time interval while displacement is the change in position of an object in a certain time interval (Kanginan, 2007).

The form of misconception that occurs can be caused by the causes that arise. Based on the research that has been done, the causes that often occur come from the students themselves with specific causes: Preconceptions or initial conceptions of students; Wrong intuition; the ability of learners; student reasoning; stage of cognitive development. Regarding the occurrence of misconceptions from students, this can occur because students' knowledge is constructed or built by students themselves. The process of knowledge construction does not only come from logical thinking but is a mixture of experience, observation, thinking ability, and language ability. Therefore, the knowledge that students construct will not be the same from one to another. So, in the learning process, students already bring concepts that are obtained through experience or observation results. The concepts owned by students are concepts that are not by experts so misconceptions are caused by the students themselves.

Based on the data analysis, there are 3 methods, 2 strategies, 9 learning models and there are also 2 approaches and various media that have been used to remediate misconceptions in kinematics. More learning models are found in remediating misconceptions in kinematics, of course, because of the many learning model developments that have been carried out by previous researchers. In addition, learning models have standard stages and each model uses different stages or syntax (Mulyatiningsih, 2015), so that in the learning process the learning activities are more organized and students are easier understand the learning material. However, every method, strategy, learning model as well as approach and media has its uniqueness, and all of them still have the same goal, namely remediating misconceptions that occur to students so students can gain new knowledge that is by the concepts of experts.

The research that has been conducted has limitations in its implementation. The following are limitations in the implementation of the research. First, articles from national and international journals that discuss the remediation of misconceptions and also the causes of students in kinematics are still limited. Secondly, the journal articles discussed in this study were limited to 5 international articles and 19 national articles. Therefore, to get all the articles that have been discussed, researchers add to the digital library used and expand the material and range of years so that the articles needed and by the specified criteria are obtained. However, in general, all articles have been able to provide information about misconceptions, causes, and remediation in kinematics.

Conclusion

Based on the results of the study, it can be concluded that for kinematics, the largest number of misconceptions appeared in straight motion, followed by parabolic motion, free fall motion, and circular motion. Several causes trigger the emergence of misconceptions in kinematics, where the causes that often arise come from the students themselves, namely, students' preconceptions or initial conceptions, students' abilities, students' cognitive development stages, wrong intuitions, and students' reasoning. There are several forms of remediation including the use of learning methods, strategies, models, approaches, and media or teaching materials. The remediation that is often used to remediate kinematics misconceptions in this study is the use of learning models, which is generative model. The generative learning model is a model that aims to change students' conceptions that are not by scientific concepts which will later be directed to be constructed with facts owned by students to produce an appropriate conclusion that is by scientific concepts. It is suggested that further research can apply the generative learning model in the physics learning.

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All authors have contribution to the completion of this manuscript. U.R has contribution in conducting research, P.D.S reviewed the manuscript, and H.H and W.S.D validated the papers used.

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