JPPIPA 9(5) (2023)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

Development of Electronic Worksheet Guided Inquiry to Reduce Misconceptions and Improve High School Students' Concept Mastery on Straight Motion Material

M. Ibnusaputra[1*], Insih Wilujeng[1], Heru Kuswanto[1]

[1] Study Program of Physics Education Postgraduate, Faculty of Mathematics and Sciences, Universitas Negeri Yogyakarta, Yogyakarta, Indonesia.

Received: December 26, 2022
Revised: May 8, 2023
Accepted: May 25, 202
Published: May 31, 2023

Corresponding Author:
M. Ibnusaputra
mibnusaputra.2021@student.uny.ac.id

DOI: 10.29303/jppipa.v9i5.2738

Abstract: This study aims to develop guided inquiry electronic worksheets that are suitable for use. Another objective is to determine the level of effectiveness of guided inquiry electronic worksheet products in reducing misconceptions and improving the mastering physics concepts in straight motion material. This Research and Development (R&D) research adapts the stages of development research from Borg and Gall. The research was conducted at SMAN 1 Gerung, West Lombok, West Nusa Tenggara. A total of 60 students in class XI MIPA for empirical trials of test instruments, and 94 students in class X MIPA for extensive trials. The data analysis technique uses 1 way ANOVA with advanced testing using partial ETA square for analyzing concept mastery, while misconceptions use Certainty Response Index (CRI) analysis. The results of expert validation on guided inquiry student worksheet development products, and supporting products in the form of lesson plans and conceptual mastery skills test instruments are included in the category of proper use and very valid. The empirical test results of the test instrument have also been categorized as valid. The application of guided inquiry electronic worksheet products based on CRI analysis effectively reduces misconceptions by 42.31%. Based on the results of the 1st ANOVA inferential statistical analysis, it was significant at 0.039, indicating that there were differences in concept mastery between students who applied guided inquiry worksheets and students in the control class. Further test results with partial ETA square also show the effectiveness of the product in the form of influence on concept mastery with a significant 0.039, which is a moderate level.

Keywords: Electronic worksheet guided inquiry; Straight Motion; Misconception; Mastery of Concept

Introduction

Physics is a discipline that requires more understanding than memorization. The ability to use three main materials is required, namely concepts, laws and theory. This subject is the key to success in studying physics (Sahara et al., 2018). These conditions cause the tendency of physics lessons to seem difficult, complicated, and confusing for students. Difficulties in learning physics can be said if a student fails to understand a concept or idea as a result of one or more (Rettob et al., 2020). This tendency arises due to the fact that solving problems cannot be separated from the relationship between material aspects. The material aspects in question are in the form of facts, concepts, laws, and theories (Herliandry et al., 2019). In essence, learning physics also has three components, namely scientific attitudes, scientific processes, and scientific products. Through learning physics can form scientific attitudes such as curiosity, open thinking, critical thinking, desire to solve problems, sensitivity to the environment, and responding to an action (Aji et al.,

How to Cite:
Ibnusaputra, M., Wilujeng, I., & Kuswanto, H. (2023). Development of Electronic Worksheet Guided Inquiry to Reduce Misconceptions and Improve High School Students' Concept Mastery on Straight Motion Material. *Jurnal Penelitian Pendidikan IPA*, *9*(5), 2653–2663. https://doi.org/10.29303/jppipa.v9i5.2738

2017). Based on this statement, the general assumption is that learning physics will direct students in finding facts, principles, theories, or mastering the concepts of the physics material. One of the subject matter in learning physics is about the kinematics of straight motion. Based on the 2013 revised 2020 curriculum, the material is for class X MIPA. The subject matter that is mutually relevant certainly has obstacles or problems in the cognitive of students. Further review is needed in the process of learning physics in this material.

Several problems can arise due to the characteristics of physics subject matter. Misconception is one form of the problem. characteristics of physics subject matter. Misconception is one form of the problem. Misconception is a problem that is often faced at various levels of educational units. All individuals will potentially experience misconceptions without realizing it (Uzun et al., 2013). Misconceptions arise as a result of erroneous ideas resulting from the construction of previous knowledge. Previous knowledge is the result of observing physical phenomena in life (Neidorf et al., 2020). According to Laliyo et al., (2019) misconceptions can occur due to several things. The causes of these misconceptions include: learning experiences that do not go through a process of direct observation.

The term misconception is used for a concept that is contrary to a scientifically accepted theory (Gurel et al., 2015). In straight motion material there are still at least 50.80% misconceptions in students. The elaboration is identifying and distinguishing between distance and displacement (54.83%), distinguishing average speed from average speed (35.48%), understanding the characteristics of measuring speed and speed (80.64%), and explaining the difference speed with position (32.25%). This description shows that straight motion material still tends to have a relatively high level of misconceptions (Nana, 2020).

There is a possibility that misconceptions also occur in the subjects of this study, it is necessary to carry out an identification step. One way to identify it is by using a diagnostic tool. Diagnostic tools can be in the form of tests/questionnaires and inventories. Other ways such as giving clinical interviews to students. Both of these methods are effective in identifying misconceptions or misunderstandings of concepts (Volfson et al., 2019). This study uses a diagnostic test as a way to identify misconceptions that occur. Another form of problem that can arise as a result of this misconception is the skill of mastering material concepts. Concept mastery is needed by students in solving problems. These skills require knowledge of theories, principles or rules based on the acquisition of previous materials (Rosdianto et al., 2017).

The forms of problems that can occur in learning physics as the current condition of students need to be underlined. Misconceptions and mastery of concepts is what is meant. An alternative assumption through this research is that there is innovation in learning products used by teachers. The innovation offered is the development of an electronic quided inquiry worksheet. That along with the development of information technology, a more innovative worksheets is needed. The worksheets can be presented in online form or with the term electronic student worksheets (Electronic worksheets). Electronic worksheets is a learning tool in the form of worksheets whose use design is assisted by the internet with systematic arrangement in electronic format (Firma et al., 2021). In this study, this electronic worksheets will contain the learning process of the guided inquiry model.

The use of guided inquiry learning models leads to a learning process that cannot be separated from scientific activities. This model is based on the discovery of material concepts through a series of experimental activities carried out by students. This scientific activity is referred to as a scientific approach with one of the results, namely an emphasis on mastering concepts (Yuliani et al., 2017). The quality of the implementation of learning using the guided inquiry model with a scientific approach is categorized as good, it can increase students' understanding of concepts, as well as students' critical thinking skills (Aji et al., 2017). Based on the syntax, the guided inquiry learning model maximizes the teacher's role in facilitating investigations. These investigative activities will direct students to scientific activities to discover the concept of a material they are studying (Pramudyawan et al., 2019).

Changes are certainly expected to occur after the implementation of this development product. The first is to reduce the misconceptions that students have. The next change is the increase in students' concept mastery. The researcher assumes that the increase in mastery of concepts is the result of the lack of material misconceptions in cognitive learners. Through electronic worksheet which contains a list of questions will direct students in scientific reasoning and build conceptual understanding of the material being studied (Barniol et al., 2016).

Method

This study aims to develop learning products in the form of guided inquiry electronic worksheets. Referring to these objectives, this research is classified as Research and Development (R&D) research. The research method used is Borg and Gall (1983). The product resulting from this development will be tested for its effectiveness in reducing misconceptions and improving students' concept mastery in straight motion material. The product is then applied to one of the research classes supported by other learning products. The other learning products developed are guided inquiry learning implementation plans (lesson plan) and Conceptual Masterytest instruments. While the diagnostic test instrument is in the form of a three tie-test by adopting the development results from Hidayatullah (2021). The use of the three tier-test can make it easier to uncover misconceptions that occur in students. its use is also able to identify the quantity of students who experience misconceptions in each sub-material (Silviani et al., 2017). The diagnostic test instrument consists of 10 questions

Product development procedures, of course, adjust to the stages of the Borg and Gall (1983) model. The results of the development will then go through a feasibility test (validation) by two expert validators and empirical testing of test instruments. The final product test design is the field test. The type of wide trial (field) is true experimental using the Pretest-Posttest Control Group Design type (Sugiyono, 2017). The treatment for each class is different, with one class doing learning with product development. Pretest-posttest used the same test instrument.

The feasibility test was carried out by the learning device expert validator and the physics material expert validator through a validation sheet. The empirical test of the instrument in question is the instrument for mastering concept skills. The test subjects were 60 class XI MIPA students. Field test subjects were carried out in 3 X MIPA classes at SMAN 1 Gerung. Analysis of the feasibility test by obtaining the average score of each validator. In contrast to the empirical test analyzed with the help of SPSS 25 to obtain the value of the validity of each item. Lastly, the analysis in the field test used the 1-way Anova test type also with the help of SPSS 25.

Result and Discussion

The resulting product will go through three test designs. These tests are feasibility tests (validation), empirical tests (validity), and field tests (area). The detailed results of each test are described below.

feasibility test (Validation)

This test is intended to determine the feasibility level of product development that can be used to reduce misconceptions and improve concept mastery. A total of 2 validators, namely expert lecturers (experts) in the material/teaching materials section, and in the test instrument section. The validator conducts an assessment (validation) of the development product on the validation questionnaire. The results are recorded in Table 1.

Table 1. Learning Product Validation Result

Learning Products	Assessment Aspect	Validator Score I	Validator Score II	Average	Assessment Criteria
Lesson Plan	Formulation of basic competence, competency achievement indicator, and learning objectives Presentation of contents Language Time Allocation	4.00	3.71	3.85	Very Worth
Electronic Student Worksheets	Presentation of contents Display formats Language and attractiveness	3.18	2.86	3.02	Worthy
Conceptual Mastery Test Instrument	Question indicator Accurate answer key	3.80	4.00	3.9	Very Valid

Based on Table 1, in general the learning products developed have been categorized as appropriate for use in learning. This category is inseparable from several forms of suggestions/input as revision materials for each learning product. The form of the suggestion/input is shown in Table 2.

Table 2. Forms of Improvement Suggestions from the Validator

Learning Products	Suggestion Validator
Lesson Plan	Adjust again between learning objectives and competency achievement indicator. Adjust again to the stages of the guided inquiry learning model on electronic worksheets.
Electronic Student Worksheets	It is necessary to clarify the guided inquiry syntax to achieve the learning objectives. Reduce the flashy colors. Links to virtual experiments and learning simulation videos should be embedded directly, not copied. The material is adjusted again to the learning objectives.
Conceptual Mastery Test Instrument	The description of the image is clarified again. Adjust the questions to the learning objectives.

	The use of language and spelling is good and correct.

Referring to Table 2, focus on the final results of developing electronic worksheets as shown in Figure 1.

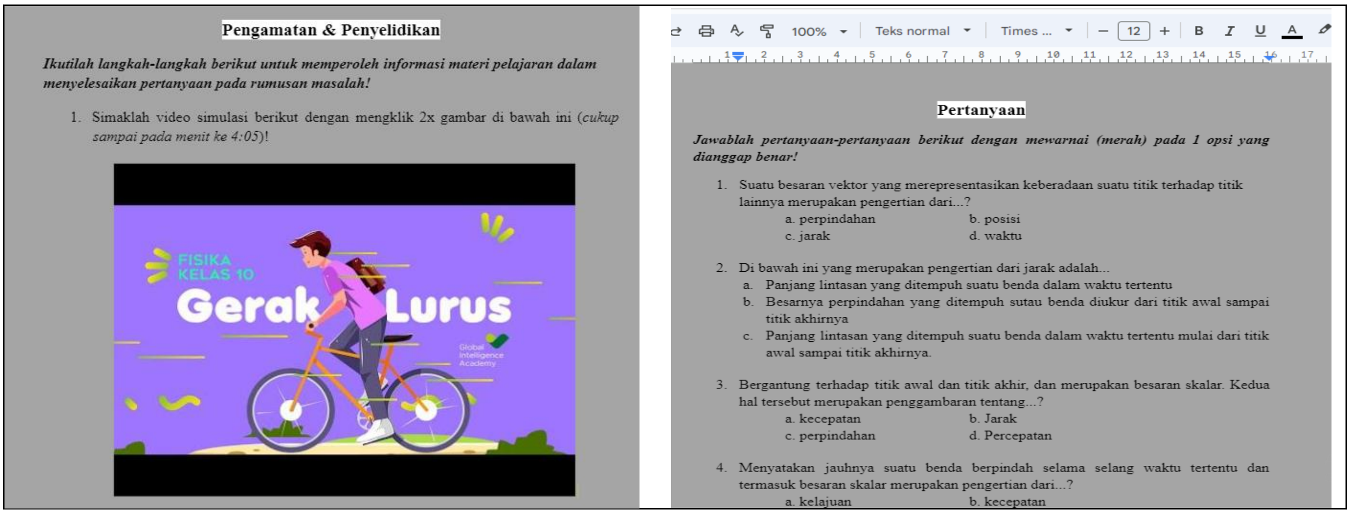

Figure 1. Display of Electronic Worksheets Core Parts

Empirical test of the test instrument (Validity)

The empirical validity test was carried out on the Conceptual Masterytest instrument. In total there are 10 items with indicators of Bloom's taxonomy (C1-C5). A total of 60 students who had studied straight motion material (XI MIPA) became the test subjects for these items. Analysis of test results using product moment correlation with the help of SPSS 25. The items in question are briefly presented in Table 3.

Table 3. Grid of Concept mastery Test Questions

Question Number	Question	Category
1, 2, 3	1. Explain the difference between uniformly rectilinear motion (URM) and uniformly changing rectilinear motion (UCRM) concepts! 2. Mention the quantities related to URM! 3. ...	C1
4, 5	4. Andi rushes to school on foot. ... 5. ...	C2
6	6. A car moves in a straight line...	C3
7, 8	7. Look at the graph of 2 motors moving against time ... 8. ...	C4
9, 10	9. If a guava fruit and a mango fruit at the same time ... 10. ...	C5

The items above were then tested empirically to determine their validity. The results of the analysis are presented in Table 4.

Table 4. Results of the Empirical Validity Test of the Concept mastery Test Instrument

Instrument Type	Question Item Number	Table *r* value (5%)	Calculated *r* value	Decision
Concept Mastery Skill Description Test	1	0.254	0.262	Valid
	2		0.330	Valid
	3		0.344	Valid
	4		0.331	Valid
	5		0.467	Valid
	6		0.346	Valid
	7		0.336	Valid

Instrument Type	Question Item Number	Table *r* value (5%)	Calculated *r* value	Decision
	8		0.597	Valid
	9		0.617	Valid
	10		0.688	Valid

The significance level used is 5%, so that with a total of 60 respondents, the r table value is 0.254. Referring to this value, Table 4 shows that all the item items are in the valid category. Fulfillment of this value states that each item is feasible to use. In contrast to the misconception diagnostic test which is in the form of a three tier-test, empirical tests are not carried out. This is because it is an adoption of the development results of Hidayatullah (2020) which has gone through the previous empirical test stage. The results show that the test instrument has a feasibility level of 2.22 (decent enough). The level of validity of the items is 0.308 (valid), so that each item (10 items) is categorized as valid.

Field test (wide)

This field test is a form of product development application in learning. Field tests used 3 classes (X MIPA 5, X MIPA 6, and X MIPA 7). Experimental class I was X MIPA 7, experiment II class X MIPA 6, and control class X MIPA 5. The analysis was carried out on the effectiveness of the product in reducing misconceptions and improving concept mastery in straight motion material. Misconception analysis using CRI (Certainty of Response Index). According to the view of Habibbulloh et al., (2017), the implementation of a three-tier-test type of misconception diagnostic test will be completed with open reasons from students. These reasons will support the answer he chose. The CRI criteria regarding misconceptions are presented in Table 5.

Table 5.CRI Criteria on Misconceptions

Answer Choices	CRI is Low (0-2)		CRI is High (3-5)	
	Correct Reason	Wrong Reason	Correct Reason	Wrong Reasong
Correct	*Lucky* (L)	Don't Understand the Concept (DUC)	Understand the Concept (UC)	False Positive Misconceptions (FPM)
Wrong	Don't Understand the Concept (DUC)	Don't Understand the Concept (DUC)	False Negative Misconceptions (FNM)	Misconceptions (M)

Referring to Table 5 above, there are 4 (four) possibility or category that can occur to students, namely guessing/lucky (L), don't understanding the concept (DUC), misconceptions (M), and understanding the concept (UC) (Busyairi et al., 2020). The results of the misconception pretest using the three tier-test are presented in Table 6.

Table 6. Frequency of Pretest Data CRI Categories

Question Item Number	Student Frequency											
	X MIPA 5				X MIPA 6				X MIPA 7			
	L	DUC	UC	M	L	DUC	UC	M	L	DUC	UC	M
1	0	1	3	27	0	7	3	22	0	0	15	16
2	0	9	1	21	1	6	5	20	0	2	1	28
3	0	12	4	15	0	7	0	25	0	1	6	24
4	0	10	2	19	0	10	2	20	0	3	7	21
5	0	12	0	19	0	13	0	19	0	3	0	28
6	0	13	1	17	0	8	0	24	0	0	1	30
7	0	11	0	20	0	6	4	22	0	1	3	27
8	0	9	0	22	0	9	0	23	0	5	9	17
9	2	8	1	20	0	13	0	19	0	2	10	19
10	0	7	3	21	0	13	0	19	0	2	13	16

Referring to Table 6, the most misconceptions occur in question number 6, namely in the experimental class I (X MIPA 7). On the other hand, the fewest misconceptions occurred in question number 3, namely in the control class (X MIPA 5). Item number 6 contains about determining the type of uniformly changing rectilinear motion (UCRM) based on observations on the graph. The dominant form of misconception occurs in these items, namely students are able to determine correctly that there is a slowdown of the UCRM process, but are unable to provide correct reasons. Other conditions, students still do not pay attention to the description of the graph axis which contains distance and speed. In contrast to item number 3 regarding the

UCRM concept. The form of misconception that occurs is that students think that UCRM moves with changing acceleration, and is unable to provide reasons for the factors that cause constant acceleration in UCRM.

Based on Table 6, it also shows that each class has a different frequency in each category of student conditions. There are 10 items with the distribution of sub-matter of uniformly rectilinear motion (URM) (numbers: 2, 4, 5 and 8), uniformly changing rectilinear motion (UCMR) (numbers: 1, 3, 5, 6 and 7), and free fall motion (FFM) (numbers: 9 and 10). The total frequency of each condition of class X MIPA 5 students (L, UC, DUC, and M) on URM material (124 times), UCRM (155 times), and FFM (62 times). The results of the first analysis, for example, about understanding the concept (PK) in the control class (X MIPA 5). Obtained URM (3 times), 8 times (UCRM), and 4 times (FFM). Between the distribution value (UC) when divided by the total frequency in URM, a 2.42% level of understanding of the concept (UC) in URM material will be obtained. Likewise with UCRM and FFM material, so that respectively 5.16% and 6.45% were obtained. The final result is that the control class average understanding of the concept (UC) on URM material will be obtained 4.67%. In further review, for example on misconceptions (M), obtained 81 times (URM), 98 times (UCRM), and 41 times (FFM). As a result, there were misconceptions about URM (65.3%), UCRM (63.2%), and FFM (66.1%). The end result is that if the three sub-materials are averaged, the students' misconceptions are 64.9%.

The same method of analysis was also carried out for each category of student conditions in each class. The results showed that the experimental class II (MIPA 6) had a misconception percentage (M) of 64.48%, and concept understanding (UC) of 3.28%. Finally, the experimental class I (MIPA 7) with a misconception (M) of 70.97%, and understanding of the concept of 22.31%. More visually seen in Figure 2.

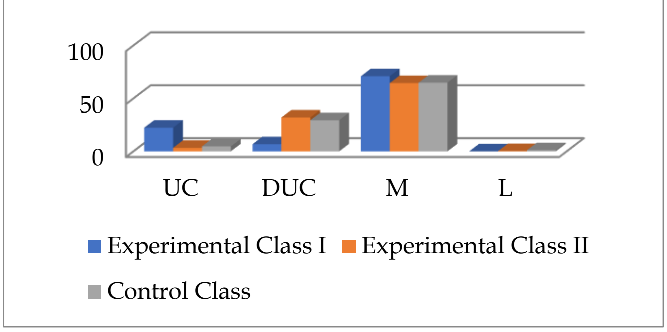

Figure 2. Pretest Misconception Data Frequency

Figure 2 shows that the tendency of students to experience misconceptions is almost the same in each class. The difference is that the experimental class I is superior in understanding the concept (UC). As a result, the opposite condition also occurs, namely the experimental class II and the control class are both superior in the category of not understanding the concept (DUC). In more detail regarding the misconception data above, it will also obtain the distribution of students' misconceptions on each sub-topic of straight motion material. The topic is divided into 3, namely URM, UCRM, and FFM. The distribution of misconception pretest data for each class on each of these sub-topics is presented in Table 7.

Table 7. Pretest Data on the Distribution of Misconceptions in the Sub-Material

Research Class	Misconception Frequency					
	Uniformly Rectilinear Motion (URM)		Uniformly Changing Rectilinear Motion (UCRM)		Free Fall Motion (FFM)	
	Time	%	Time	%	Time	%
Control (X MIPA 5)	81	65.3	98	63.2	41	66.1
Experimental II (X MIPA 6)	82	64	112	70	38	59.4
Experimental I (X MIPA 7)	94	75.8	125	80.6	35	56.45

Table 7 shows that the highest distribution of misconceptions is the UCRM topic with 80.6% (125 times) of students experiencing misconceptions in the experimental class I. The misconception conditions in UCRM are like, students still think the speed is constant, the acceleration changes, and can't differentiate UCRM is slowed down with accelerated UCRM. Meanwhile, there are misconceptions about URM, such as students not being able to distinguish between distance and displacement. Finally at URM, students still think that falling objects also depend on the mass of objects. Another condition is reflected in Table 7, which is that the highest average percentage of students tends to experience misconceptions about the sub-matter of uniformly changing rectilinear motion. The tendency is 71.26% (high).

The three research classes were then given different learning treatments. Data from posttest misconceptions are presented in Table 8. The data in Table 8, if it refers to the same analytical method as the previous pretest data, some data will be obtained. First for the control class, understanding the concept 45.9%, and misconceptions 49.4%. Experimental class I, understand the concept 68%, and misconceptions 28.65%. Finally, the experimental class II, understanding the concept 52.8%, and misconceptions 40.26%.

Referring to these data, there was a decrease in misconceptions for the control class 15.49%, the experimental class II 24.22%, and the experimental class I 42.31%. The difference in the reduction of misconceptions for each class proves that product development succeeded in reducing misconceptions with the highest percentage of reduction. Another fact is in the form of the highest increase in conceptual understanding, as shown in Figure 3.

Table 8. Frequency of Posttest Data CRI Categories

Question Item Number	Student Frequency											
	X MIPA 5				X MIPA 6				X MIPA 7			
	L	DUC	UC	M	L	DUC	UC	M	L	DUC	UC	M
1	0	0	20	11	1	0	26	5	0	0	26	5
2	0	0	21	10	0	0	28	4	0	0	28	3
3	0	0	7	24	2	2	16	12	0	0	24	7
4	0	1	20	10	0	6	18	8	0	0	23	8
5	0	0	12	19	0	0	22	10	0	0	27	4
6	0	0	10	21	1	4	20	7	0	1	26	4
7	1	2	12	16	0	2	22	8	0	2	12	17
8	0	4	9	18	0	5	6	21	0	2	9	20
9	0	2	15	14	0	2	13	17	0	3	16	12
10	0	3	15	13	0	1	9	22	0	1	21	9

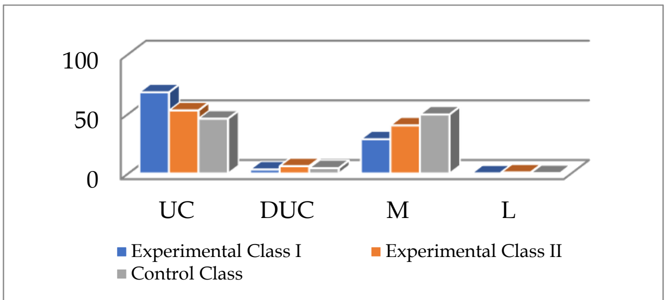

Figure 3. Posttest Misconception Data Frequency

Graph 3 shows the condition of the students after being given different learning treatments. Experimental class I students excelled in each category, especially in the conceptual understanding category which was higher than the other classes, and the misconception category which was lower than the other classes. If the frequency is described in more detail on each material sub-topic, it will be presented as in Table 9.

Table 9. Posttest Data on the Distribution of Misconceptions in the Sub-Material

Research Class	Frekuensi Miskonsepsi					
	URM		UCRM		FFM	
	Time		Time		Time	
Control (X MIPA 5)	57	45.9	91	58.7	27	43.54
Experimental II (X MIPA 6)	43	33.6	42	26.25	39	60.9
Experimental I (X MIPA 7)	35	28.2	37	23.8	21	33.87

Data from Table 9, when compared with Table 7, the spread of misconceptions in the experimental class I has decreased. The decrease in misconceptions for each sub-material became 23.8% (UCRM), 28.2% (URM), and 33.87% (FFM). This decrease in distribution means that the Guided Inquiry electronic worksheet product has been able to reduce students' misconceptions about straight motion material. Behind this success, there is still a remaining percentage of misconceptions. The percentage decrease shows that there are still misconceptions in students. This condition supports facts about misconceptions that are difficult to correct according to Masson, et al. (2014). Based on Table 9, it also shows different conditions from Table 7. This condition is the tendency of students to experience misconceptions. The highest average percentage of students experienced misconceptions in the free fall motion sub-material, amounting to 46.1% (medium).

The application of learning using guided inquiry electronic worksheets has shown to be able to remediate misconceptions. One of the factors is that electronic worksheets are learning media that are able to attract the attention, interest, and attitude of students towards the teaching process. The views of Daesang, et al. (2013), students' perceptions of the teaching process will have an impact on their performance. The better the perception, the better their performance will be. Performance can be interpreted as the ability of students to follow the process and understand the learning material. Improving this perception can be done by using the right learning media. As a result, students are motivated in learning.

Another factor is the inclusion of a virtual laboratory in the electronic worksheet. As a result, students are increasingly directed to increase learning activities or experiences. As a result, students can visualize the concept of knowledge they have. According to Yusuf and Subaer (2013), a virtual laboratory is defined as a series of computer programs that can visualize abstract phenomena. The existence of a virtual laboratory is also able to facilitate complex experiments to be carried out in real time. As a result there is an increase in student learning activities. These learning activities are in an effort to develop the skills needed to solve the problems they find.

Analysis of the results of product implementation was also carried out to determine its effectiveness in improving concept mastery. The 1 way Anova test was used to determine the effectiveness. This Variance analysis is by knowing the difference in the average parameters of two or more sample groups (Kadir, 2018). The posttest data of conceptual mastery skills was used, and previously went through the prerequisite test (normality and homogeneity) of the 1st Anova. The prerequisite test results are presented in Tables 10 and 11.

Table 10. Normality Test Results

Data	Research Class	Shapiro-Wilk test	
		Df	Sig.
Posttest Concept mastery	Control (X MIPA 5)	31	0.119
	Experimental II (X MIPA 6)	32	0.393
	Experimental I (X MIPA 7)	31	0.294

Table 11. Homogeneity Test Results

		Levene Statistic	df1	df2	Sig.
Concept mastery	Based on Mean	2.758	2	91	0.069
	Based on Median	2.523	2	91	0.086
	Based on Median and with adjusted df	2.532	2	81.388	0.086
	Based on trimmed mean	2.696	2	91	0.073

Based on Tables 10 and 11, it can be stated that the posttest data for mastery of the concept has been normally distributed and homogeneous. The proof is from each significance value which is more than 0.05 (Sig> 0.05). ANOVA test 1 way posttest data was carried out to determine differences in concept mastery due to learning treatments with and without product development. This difference indirectly indicates the effectiveness of the development product. The test results are presented in Table 12.

Table 12. ANOVA Test Results One Way Data Posttest Mastery of Concepts

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	12217.693	2	6108.846	3.362	0.039
Within Groups	165352.520	91	1817.061		
Total	177570.213	93			

The significance value was 0.039 (Sig. <0.05), so it was concluded that there were differences in the students' concept mastery in the three research classes. Such results still need further detailed exploration of the effect of product development on research class groups. The use of the posthoc test to answer it, and the results are presented in Table 13.

Table 13. Posthoc Test Results

Test Type	(I) Research Class	(J) Research Class	Mean Difference (I-J)	Sig.
Bonferroni	Control	Experimental II	-13.35685	0.651
		Experimental I	-28.06452*	0.033
	Experimental II	Control	13.35685	0.651
		Experimental I	-14.70766	0.523
	Experimental I	Control	28.06452*	0.033
		Experimental II	14.70766	0.523

The elaboration from Table 13, that between the control class and the experimental class I had a significance value of 0.033 (Sig. <0.05), so it was concluded that there was an effect of electronic guided inquiry student worksheets on concept mastery among students in that group. In contrast to the control class with experimental class II and experimental class II with experiment II (Sig.> 0.05), it can be concluded that there was no effect of electronic guided inquiry student worksheets on concept mastery between the groups.

It is necessary to further determine the level of influence of the learning treatment through the application of product development. The effect size test is used to determine the level of influence (Cohen, 1988). The results are presented in Table 14.

Table 14. Effect Size Test Results

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	12217.693[a]	2	6108.846	3.362	0.039	0.069

Referring to Table 14, with an effect size partial eta squared test value of 0.069, it can be concluded that the magnitude of the effect of the treatment is at a moderate level. Medium level refers to the effect of the learning treatment using guided inquiry electronic worksheets on the concept mastery of each student in each research class. The moderate level in question can also be proven in the frequency of changes in the average value of each class. The visuals are shown in Figure 4.

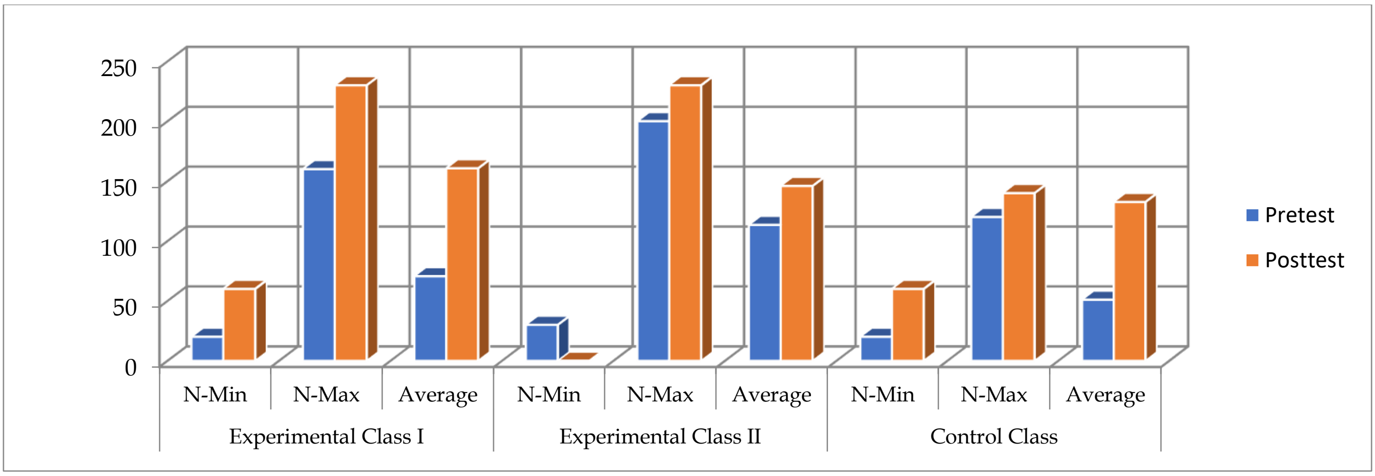

Figure 4. Pretest-Posttest Value Comparison

Based on Figure 4, it shows that there are differences or differences in the values of each class. The experimental class I with the application of product development has an average value that is greater than the other classes, namely 160.7 for the posttest value. Previously, the average value of the experimental class I pretest was 70.62, so that it reflected an increase in mastery of the concept from the difference in value. The difference when percentaged is equal to 56.05%.

The increase in the average score of the mastery of the concept test results shows a new fact. The fact is that the application of guided inquiry electronic worksheets is proven to be a solution in improving students' concept mastery. One of the causes is due to the application of the guided inquiry learning model. Pramudyawan et al., (2019), based on the syntax of guided inquiry learning, the role of the teacher facilitates investigation and directs students in scientific activities to discover material concepts. Scientific activities have been able to be presented in guided inquiry electronic worksheet learning, in the form of observation and investigation activities

Conclusion

Referring to the learning device products resulting from the development and description of the discussion, several points can be underlined as conclusions. First, the electronic Guided Inquiry student worksheet that was developed was in the appropriate category to be used to reduce misconceptions and improve students' skills in mastering the concept of straight motion material. Guided Inquiry electronic student worksheet is also effective for reducing misconceptions, and improving students' concept mastery. The proof is shown by the difference in percentage reduction in misconceptions and differences in concept mastery between the experimental class I using the Guided Inquiry electronic student worksheet learning and the control class. The application of guided inquiry electronic worksheet products based on CRI analysis is effective in reducing misconceptions at a moderate level. Other results in the inferential statistical analysis of way ANOVA were significant at 0.039, indicating that there were differences in concept mastery between students who applied guided inquiry worksheets and students in the control class. Further test results with partial ETA square also show product effectiveness in the form of influence on concept mastery with a significant 0.069, which is a moderate level. Apart from that, further innovation is still needed for product development. Product development can also be used as an alternative to straight motion learning material. It can also be used as a reference for physics learning products for material which indicates a high percentage of misconceptions and a relatively low level of concept mastery.

Acknowledgments
Thanks and appreciation were conveyed to the thesis supervisor (Prof. Dr. Insih Wilujeng, M.Pd), lecturers in charge of scientific work courses (Prof. Dr. Heru Kuswanto, M.Sc), and the campus. This was conveyed with guidance and administrative permission to conduct research related to this article.

Author Contributions
Conceptualization and research methodology by M. Ibnusaputra, and Insih Wilujeng; validation by Insih Wilujeng, and Heru Kuswanto; formal analysis and investigation by M. Ibnusaputra; wrote the preparation of the original draft by M. Ibnusaputra, Insih Wilujeng, and Heru Kuswanto; wrote review and edited by M. Ibnusaputra.

Funding
This research received no external funding.

Conflicts of Interest
The authors declare no conflict of interest.

References

Aji, S. D., Bernadino, A., & Hudha, N. M. (2017). Inkuiri Terbimbing dengan Pendekatan Saintifik (*Scientific Approach*) untuk Meningkatkan Berpikir Kritis. *Jurnal Momentum: Physics Education Journal, 1(2)*: 140-147. *http://ejournal.unikama.ac.id/index.php/momentum/index*

Barniol, P., & Zavala, G. (2016). A tutorial worksheet to help students develop the ability to interpret the dot product as a projection. *Eurasia Journal of Mathematics, Science and Technology Education, 12(9)*: 2387–2398. https://doi.org/10.12973/eurasia.2016.1271a

Borg, W. R. & Gall, M. D. (1983). *Educational Research: An Introduction, Fifth Edition*. New York: Longman.

Busyairi, A., & Zuhdi, M. (2020). Profil Miskonsepsi Mahasiswa Calon Guru Fisika Ditinjau Dari Berbagai Representasi Pada Materi Gerak Lurus Dan Gerak Parabola. *Jurnal Pendidikan Fisika Dan Teknologi, 6(1)*: 90–98. https://doi.org/http://dx.doi.org/10.29303/jpft.v6i1.1683

Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences*; Second Edition. New York: Lawrence Erlbaum Associates.

Daesang, K., Dong-Joong K., &Woo-Hyung W. (2013). Cognitive Synergy in Multimedia Learning. *International Education Studies*, *6(4)*: 76-84. http://dx.doi.org/10.5539/ies.v6n4p76

Firma, Y. K., Agustinigsih, A., & Aguk, A. W. (2021). Pengembangan Lembar Kerja Peserta Didik Elektronik (E-LKPD) Berbasis Higher Order Thinking Skill (HOTS). *Jurnal Edustream: Jurnal Pendidikan Dasar, 5(2):* 143-150. http://dx.doi.org/10.22032/jpd.v3a1.5537

Gurel, D. K., Eryilmaz, A., & Mcdermott, L. C. (2015). A Review And Comparison Of Diagnostic Instruments To Identify Students' Misconceptions In Science. *Eurasia Journal Of Mathematics, Science And Technology Education, 11(5)*: 989–1008. https://doi.Org/10.12973/Eurasia.2015.1369a

Habibbulloh, M., Jatmiko, B., & Widodo, W. (2017). Pengembangan Perangkat Pembelajaran Model Guided Discovery Berbasis Lab Virtual untuk Mereduksi Miskonsepsi Siswa SMK Topik Efek Fotolistrik. *Jurnal Penelitian Fisika dan Aplikasinya, 7(1)*: 27-42. https://doi.org/10.26740/jpfa.v7n1.p27-43

Herliandry, L. D., & Harjono, A. (2019). Kemampuan Berpikir Kritis Fisika Peserta Didik Kelas X Dengan Model Brain Based Learning. *Jurnal Penelitian Pendidikan IPA, 5(1)*: 1-9. https://doi.org/10.29303/jppipa.v5i1.166

Hidayatullah, Z. (2021). *Pengembangan Perangkat Pembelajaran Fisika Berbasis CCM Bermuatan Konflik Kognitif untuk Mereduksi Miskonsepsi dan Meningkatkan Kemampuan Berpikir Kritis Peserta Didik*. Yogyakarta: Universitas Negeri Yogyakarta.

Kadir, K. (2018). *Statistika Terapan: Konsep, Contoh, dan Analisis Data dengan Program SPSS/Lisrel dalam Penelitian*. Depok: PT Raja Grafindo Persada.

Laliyo, L. A. R., Botutihe, D. N., & Panirogo, C. (2019). The Development of Two-Tier Instrument Based on Difractor to Asses Conceptual Understanding Level and Student Misconceptions in Explaining Redox Reactions. *International Journal of Learning, Teaching, and Educational Research, 18(9), 216-237*. https://doi.org/10.26803/ijlter.18.9.12

Masson, S., Potvin, P., Riopel, M., & Foisy, L (2014). Differences in Brain Activation Between Novices and Expert in Sciences During a Task Involving a Common Misconception in Electricity. *International Mind, Brain, and Education Society and Wiley Periodical*, *8(1)*: 44-55. http://dx.doi.org/10.1111/mbe.12043

Nana, N. (2020). Penerapan Model Pembelajaran Inkuri Terbimbing untuk Mereduksi Miskonsepsi pada Konsep Gerak Lurus Siswa SMA Kelas X. *Jurnal DIFFRACTION: Journal for Physics Education and Applied Physics, 2(1)*: 1-8. https://doi.org/10.37058/diffraction.v2i1.1799

Neidorf, T., Arora, A., Erberber, E., Tsokodayi, Y., & Mai, T. (2020). *Student Misconceptions and Errors in Physics and Mathematics*. Switzerland: Springer Nature.

Pramudyawan, M. T. S., Doyan, A., &'Ardhuha, J. (2019). Pengaruh Model Pembelajaran Inkuiri Terbimbing Berbantuan Kit Alat Percobaan Usaha dan Energi terhadap Penguasaan Konsep Fisika Peserta Didik. *Jurnal Penelitian Pendidikan IPA, 6(1)*: 40-44. https://doi.org/10.29303/jppipa.v6i1.290

Rettob, J., Poluakan, C., Tulandi, D.A., Mongan, S. W., and Polii, J. (2020). Students Learning Difficulties In Understanding The Lorentz Force. *Journal of Physics: Conference Series, 2021(012041)*. https://doi.org/10.1088/1742-6596/1968/1/012041

Rosdianto, H., Murdani, E., & Hendra, H. (2017). The Implementation of POE (Predict Observe Explain) Model to Improve Student's Concept Understanding on Newton's Law. *Jurnal Pendidikan Fisika Unimed, 6(1)*: 55-57. https://jurnal.unimed.ac.id/2012/index.php/jpf/article/view/6899/5924

Sahara, L., Fayanto, S., Nafarudin, N., & Tairjanovna, B. A. (2020). Analysis of Improving Students' Physics Conceptual Understanding through Discovery Learning Models Supported by Multi-representation: Measurement Topic. *journal Indonesian Review of Physics, 3(2)*: 57-65. https://doi.org/10.12928/irip.v3i2.3064

Silviani, R., Muliyani, R., & Kurniawan, Y. (2017). Penerapan Three Tier-Test untuk Mengidentifikasi Kuantitas Siswa yang Miskonsepsi Pada Materi Magnet. *Jurnal Ilmu Pendidikan fisika, 2(1)*: 10-11. https://dx.doi.org/10.26737/jipf.v2i1.197

Sugiyono, S. (2017). *Metode Penelitian Pendidikan: Pendekatan Kuantitatif, Kualitatif, dan R&D*. Bandung: Alfabeta.

Uzun, S., Alev, N., & Karal, I. S. (2013). A Cross-Age Study of sn Understanding of Light and Sight Concepts in Physics. *Science Education International,24(2)*:129-149. http://files.eric.ed.gov/fulltext/EJ1015829.pdf.

Volfson, A., Eshach, H., & Ben, Y. A. (2019). Identifying physics misconceptions at the circus: The case of circular motion. *Jurnal Physical Review Physics Education Research, 16(1)*: 1-11. http://dx.doi.org/10.1103/PhysRevPhysEducRes.16.010134

Yuliani, H., Mariati, M., Yulianti, R., & Herianto, C. (2017). Keterampilan Berpikir Kreatif Pada Siswa Sekolah Menengah Di Palangka Raya Menggunakan Pendekatan Saintifik. *Jurnal Pendidikan Fisika dan Keilmuan (JPFK). 3(1),* 48-56. http://doi.org/10.25273/jpfk.v3i1.1134

Yusuf, I., & Subaer, S. (2013). Pengembangan Perangkat Pembelajaran Fisika Berbasis Media Laboratorium Virtual Pada Materi Dualisme Gelombang Partikel Di SMA Tut Wuri Handayani Makassar. *Jurnal Pendidikan IPA Indonesia 2(2)*: 189-194. https://dx.doi.org/10.15294/jpii.v2i2.2722