The Effect of Interactive Learning Media Using Visual Basic for Application Excel Spreadsheet to Reduce Misconception in Physics Learning

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Abstract: Misconceptions in physics learning are often caused by students' preconceptions that are not in accordance with the actual physics theory. The use of interactive digital technology-based learning media makes it easier for students to understands physics concepts. This research aims to apply interactive learning media based on Visual Basic for Application (VBA) excel spreadsheets to remediate misconceptions in traveling wave material. The research method is a pre-experimental design, with one group for pretest and posttest. A total of 21 samples were selected using purposive sampling technique. Data collection was carried out twice, namely during the pretest and posttest using a five-tier multiple choice diagnostic test with 10 questions. The results of the misconception remediation analysis showed a decrease in misconceptions from 28.5% to 11.3% with an average N-Gain score (-0.31). This means that there was a decrease in the percentage of misconceptions before and after treatment. This data is also supported by the results of the paired sample t-test analysis, namely $0.000 < 0.5$, which means that the use of interactive learning media based on Visual Basic for Application (VBA) Excel spreadsheets has a significant effect on remediating students' misconceptions about traveling wave material. This interactive learning media is expected to be an alternative for teachers in remediating misconceptions in learning physics.

Keywords: Interactive learning media; Misconceptions; Traveling wave; Visual basic for application

Introduction

The integration Information Communication and Technology (ICT) in education in the 21st century is believed to help educational institutions both academically and administratively. The government has supported the use of ICT in learning as stated in Ministry of National Education Regulation No 78/2009, The learning process applies Information and Communication Technology-based, active creative, effective, fun, and contextual learning approaches. The influence of Information and Communication Technology in the development of education can improve the efficiency and effectiveness of teaching and learning in Indonesia (Harahap, 2019). The ability to use technology in teaching materials has become an important skill for mathematics teachers and is an important topic in the current research (Wijaya et al., 2020). One of the utilizations of digital technology in learning is as an interactive learning media.

Interactive learning media can be defined as everything related to software and hardware that can be used as an intermediary to convey material content (Sutarti et al., 2017). Interactive multimedia is multimedia that has navigation tools or other features that allow multimedia users to establish two-way

communication (Suryani, 2018). The main advantage of interactive learning media is that interactivity itself opens up various opportunities for interaction between users and the media (Wibawanto, 2017).

Based on previous research show interactive learning media based on Power Point is feasible for use in the learning process of Mathematics (Gulo et al., 2022), Interactive simulation of parabolic motion using VBA Excel in physics learning showed valid and reliable results (Swandi et al., 2021). Bertacchini et al. (2019) on the role of computer simulations in learning analytic mechanics towards chaos theory states that students' concept understanding of mechanical analysis using computer simulations obtained higher results. Cárdenas-Sainz et al. (2023) on the evaluation of extended reality (XR) technology on motivation for learning physics showed that the use of PhysXR tools, both VR and AR approaches, resulted in a significant increase in learning gains and motivation. Then, Banda et al. (2023) on the impact of Physics Education Technology (PhET) interactive simulation-based learning on motivation and academic achievement in learning oscillations and waves showed that PhET simulation-based learning enhances the learning of oscillations and waves as it provides visualization and teaching aids that help to understand the knowledge content easily.

Microsoft Excel-based interactive learning media is one type of software-based interactive learning media (Gunawan, 2022). By using the main Microsoft Excel software, it can be used to create learning media according to the curriculum, material, and characteristics of students. One example of Microsoft Excel-based interactive learning media is on the concept of Volumetric Titration in chemistry learning (Khaldun, 2019). Visual Basic for Application (VBA) is a program to create Microsoft Windows-based applications quickly and easily. Visual Basic provides tools to create simple applications to complex or complicated applications for companies with larger systems (Sunyoto, 2007). Macros are a set of instructions that automate some aspects of Excel so that it can work more efficiently and faster (Lee, 2012).

Physics learning should emphasize concepts concerning products, processes, and scientific attitudes. According to Soeharto et al. (2019), Physics is the field where misconceptions are most common. Misconception is an erroneous idea about a concept that is not in accordance with the concept of experts (Ibrahim, 2012). Physics misconceptions of high school students in the last five years have decreased and increased, the majority of the causes of physics misconceptions in students occur due to the mismatch of students' preconceptions with the concepts of

scientists (Sari, 2018). There are so many misconceptions that occur in physics subjects and one of the materials that allow misconceptions to occur in students is mechanical wave material (Widiyanto et al., 2018).

Based on preliminary research at SMAN 1 Lhoknga during physics learning, many students do not have preconception understanding of the material taught or have preconception understanding but not in accordance with the actual physics theory. Physics teachers still use lecture and discussion learning methods when learning takes place. According to Suparno (2013), said that the initial concepts owned by students often contain misconceptions that often cause misconceptions. In addition, the lecture and discussion teaching methods used by teachers can also cause misconceptions.

Through interactive learning media can be one way to remediate students' misconceptions about a concept. Based on the research results from Sa'diyah et al. (2021) about the development of interactive learning media C-bonds to detect and reduce misconceptions with Conceptual Change Text strategy on Chemical Bonding material showed a reduction in misconceptions of 87.95%, including in the very effective category. The application of interactive learning media based on Microsoft Excel can reduce the quantity of student misconceptions on acid-base titration material from 34.3% before learning to 10.3% after treatment (Nurhafidhah et al., 2018). Further research result from Elfina et al. (2017), the use of macromedia flash assisted spreadsheet to remediate misconceptions on liquid pressure in junior high school stated that the misconception profile showed significant changes from 9.48 % in the pretest to 0.78 % in the post-test.

Based on the description above, the researcher wants to develop an interactive learning media using computer software, namely the Visual Basic for Application feature on Microsoft Excel to reduce students' misconceptions on traveling wave. Traveling waves can be visualized using computer simulations, such as using a combination of spreadsheets and Visual Basic for Application (VBA). The reductions of misconceptions in traveling waves using this computer tools is one of the novelties of this study. Therefore, the aim of this study is to determine the effectiveness of misconception remediation using interactive learning media based on Visual Basic for Application (VBA) Excel Spreadsheet.

This research question on this study are as follow: how is the feasibility of interactive learning media based on Visual Basic for Application (VBA) Excel Spreadsheet in physics learning, how the treatment effect on the reduction of student misconceptions in traveling wave topi, analysis of student's misconception sources, and

analysis of the effect of using interactive learning media based on Visual Basic for Application excel spreadsheet.

Method

This is a quantitative approach research with a one-group pretest-posttest design. This one-group pretest and post-test design were carried out on one group without a control or comparison group (Wulandari et al., 2021). The research subjects were selected using a purposive sampling technique. The sample for this research consisted 21 student of 12th grade science students from SMAN 1 Lhoknga.

This research uses a five-tier diagnostic test to identify the level of students' misconceptions on traveling waves in physics learning. This five-tier test is a development of the four-tier test which added a questionnaire of learning resources in the fifth level to determine the causes of misconceptions experienced by students (Yusup, 2018). Decision-making on students' answers is guided by research (Gurel et al, 2015) as shown in table 1 below.

Table 1. Category of Student Understanding

1st tier	2st tier	3st tier	4st tier	Category
Corect	Sure	Corect	Sure	SC
Corect	Sure	Corect	Not Sure	LK
Corect	Not Sure	Corect	Sure	LK
Corect	Not Sure	Corect	Not Sure	LK
Corect	Sure	Wrong	Sure	FP
Corect	Sure	Wrong	Not Sure	LK
Corect	Not Sure	Wrong	Sure	LK
Corect	Not Sure	Wrong	Not Sure	LK
Wrong	Sure	Corect	Sure	FN
Wrong	Sure	Corect	Not Sure	LK
Wrong	Not Sure	Corect	Sure	LK
Wrong	Not Sure	Corect	Not Sure	LK
Wrong	Sure	Wrong	Sure	MSC
Wrong	Sure	Wrong	Not Sure	LK
Wrong	Not Sure	Wrong	Sure	LK
Wrong	Not Sure	Wrong	Not Sure	LK

Table 1 shows the combination of students' answers in five categories, namely scientific conception (SC), false positive (FP), false negative (FN), misconception (MSC), and lack of knowledge (LK). The data collection was collected twice, namely giving pretest questions to students before treatment and posttest after treatment. The instrument of five-tier diagnostic test has been validated by a lecturer at the Department of Physics at Syiah Kuala University, who states that all the items hold high validity, signifying that they can measure the formulated indicators, are conceptually correct and do not cause ambiguity (Utomo, 2019). The instrument also

has been tested on small groups with 10 students who have studied of the traveling wave topic. Validity and reliability results as shown in Table 2. Based on the results of instrument trials on small groups as shown in Table 2, it can be concluded that the five-tier diagnostic test had validity and reliability that were very feasible and reliable. The test consisted of 10 questions with five tiers; The first level is question answer choices, the second level is confidence of question answer, the third level is the reason for the answer at first level, the fourth level is confidence in the reasoning of answers at the third level, and the fifth level is source of answers to the first and third level questions.

Data analysis in this study was carried out in 2 stages. The first stage was the qualitative analysis of the feasibility media (VBA Excel Spreadsheet) and student's misconceptions sources in physics learning. The validity and reliability of media feasibility instrument were calculated using Aiken's formula and Inter-Rater Agreement (IRA). The second stage, quantitative analysis of students' misconception reduction after treatment. Calculation of misconception reduction using normality gain (Salimah et al., 2018). The normality test with Shapiro Wilk test (Wahjusaputri et al., 2022) and *Paired sample t-test* to assess the effectiveness of the treatment (Muhid, 2019).

Result and Discussion

In accordance with the objectives of the study as formulated in the introduction, the data displayed are related to (1) The feasibility of interactive learning media based on Visual Basic for Application (VBA) Excel Spreadsheet in physics learning, (2) the treatment effect on the reduction of student misconceptions, and (3) Analysis of student misconception sources.

The Feasibility of Interactive Learning Media Based on Visual Basic for Application Excel Spreadsheet in Physics Learning

The feasibility of learning media is assessed by media and material experts (Sugiyono, 2019). Assessment of learning media is based on aspects of the accuracy of media display, media feasibility, and writing. Then the material assessment is based on aspects of material suitability and quality of material.

The results of the validity test, using the Aiken Index, and the reliability test, using the Inter-Rater Agreement (IRA) on the interactive learning media based on Visual Basic for Application Excel Spreadsheet can be seen in Table 3. Based on Table 3, the results of calculating the Aiken index for the media category is 0.80 and for material is 0.81 with an average score of 0.80. Based on the assessment results by experts who have calculated using the Aiken Index, it

can be concluded that the media and materials are valid. Furthermore, the calculation result from the Inter-Rater Agreement (IRA) for the media category is 0.874, and for the material is 0.825, with an average score of 0.85. The results of this average score indicate that the level of agreement from experts are assessed is not coincidental (Excellent agreement beyond chance) (Shweta et al., 2015).

Table 2. Validity and Reliability of Five-Tier Diagnostic Test

	Reliability			Validity		
Cronbach's Alpha	Total N of Items	Interpretation	Pearson Correlation		Total N of Items	Interpretation
Sig < α			Sig < α			
0.81	10	Very Reliable	0.75		10	Very Strong

Table 3. Validity and Reliability of VBA Media

Categories	Aiken's Index	Validity	Inter-Rater Agreement (IRA)	Reliability
Media	0.800	Valid	0.87	(Excellent agreement beyond chance)
Materials	0.812	Valid	0.82	(Excellent agreement beyond chance)
Average	0.80	Valid	0.85	(Excellent agreement beyond chance)

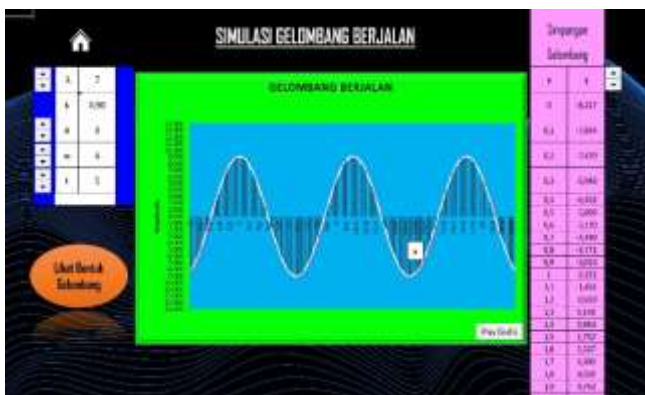**Figure 1.** VBA media display

Figure 2. VBA simulation display

In physics learning, interactive media based on computer simulation is widely used. The evidence based on experimental studies suggests that we can improve learning by integrating computer simulations on topics that students find conceptually difficult. Additionally, computer simulations may allow students to visualize objects and processes that are normally beyond the user' control in the natural world. The contribution of interactive media based on computer simulation in physics learning can reduce students' misconceptions and improving concept understanding of physics materials with Modellus Software (Sarabando, 2014); PhET simulations (Luchembe, 2022); and Excel modelling tools (Malone et al., 2018).

The Treatment Effect on the Reduction of Student Misconceptions in Traveling Wave Topic

The implementation of the research began by giving a five-tier diagnostic test to respondents to identify the level of students' misconceptions on traveling waves in the form of a pretest. Then continued with giving treatment, namely the explanation of the traveling wave material using interactive learning media based on Visual Basic for Application (VBA) Excel Spreadsheet. Interactive media based on Visual Basic for Application (VBA) Excel Spreadsheet features material, interactive simulations, and comprehension test. At the end of the lesson, all respondents were required to answer a five-tier diagnostic test on the posttest to identify the reduction of misconceptions on the traveling wave topic. Based on instrument of a five-tier diagnostic test, students are grouped based on their understanding categories, namely Scientific Conceptions (SC), False Positive (FP), False Negative (FN), Misconception (MSC), and Lack of Knowledge (LK). According to the result of pretest and posttest, percentage of students understanding categories as shown in Table 4.

Table 4. The Resul of Pretest and Posttest

Category	Percentage (%)	
	Pretest	Posttest
Scientific Knowledge (SC)	12.3 %	43.3 %
Lack of Knowledge (LK)	35.2 %	14.7 %
False Positive (FP)	11.9 %	20.9 %
False Negative (FN)	11.9 %	9.5 %
Misconceptions (MSC)	28.5 %	11.4 %

The results of data analysis based on students' answers on the pretest in Table 4 showed that the category of Scientific Knowledge (SC) is 12.3 %, lack of nowledge (LK) is 35.5 %, false positive (FP) and false negative (FN) are 11.9 %, and students' misconceptions (MSC) is 28.5 %. The identification results showed that the percentage of students' misconceptions on traveling wave material is in the low category. the largest percentage of student answers is in the LK category, this shows that more students do not understand the concept. Students who understand the concept (SC) are only about 12.3 %.

After the treatments, the results of data analysis based on students' answer on the posttest showed that the SC category increased to 43.3 %, this means that there is an increase in students' concept understanding. The percentage of the LK category dropped to 14.7 %, this mean there was a decrease in the percentage of students who did not understand the concept. The percentage of misconceptions (MSC) dropped to 11.4 %, this mean there is a decrease in misconceptions after students learning traveling wave material using interactive media based on Visual Basic for Application Excel Spreadsheet. Based on the results of identifying students' misconceptions on traveling wave material during pretest and posttest, it can be concluded that there is a decrease in the percentage of students' misconceptions from 28.5% to 11.4%, and there is an increase in students' understanding of concepts in the material of traveling waves from 12.3 % to 43.3 % after using interactive learning media based on VBA excel spreadsheet.

Scientific Conception is meaning that students who really understand the concept actually, Lack of Knowledge means students do not know the concept, False Positive is in the firsts tier learners answer correctly but incorrectly in the third tier and are confident in their answer, False negative means that in the first tier the learner answers incorrectly but is correct in the third tier and is confident in their answer (Kamal et al., 2019). According to Sari (2018), stated that misconception can be defined as a conception that is not in accordance with scientific understanding or understanding accepted by scientists. So, in answering the questions, the students' answers were wrong in tier 1 and 3 but were confident in their answers.

The Reduction of Student's Misconceptions

The results of collecting data on students' misconceptions in this study used a five-tier multiple-choice diagnostic test consisting of 10 questions. N-gain test is used to see the decrease in students' misconceptions. Figure 3 shows the students' misconception index on traveling waves topic for each student after using interactive learning media based on

Visual Basic for Application Excel Spreadsheet. Based on Figure 1, it shows that students experienced a decrease in misconceptions, an increase in misconceptions and neutral misconceptions. There were 18 students who experienced a decrease in misconceptions with N-gain index (-0.13), (-1.50), (-0.60), (-0.25), (-0.25), (-0.13), (-0.13), (-0.25), (-0.13), (-0.29), (-0.43), (-0.14), (-1.00), (-0.25), (-0.29), (-0.29), (-0.60), and (-0.25). The highest index is (-1.50), (-1.00), dan (-0.60). This mean, the student 2, 15, 3 and 19 experienced the highest decrease in misconceptions on each question. Then there were 2 student who experienced an increase in misconceptions with low index (0.11) and (0.29). Furthermore, there were only one student did not have misconceptions (neutral).
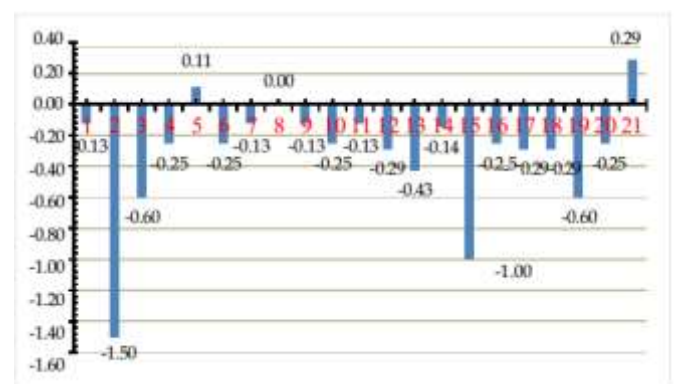

Figure 3. The reduction of misconceptions for each student

Furthermore, the data in Figure 3 can also be linked to learning style data (which was obtained during the preliminary study of this research), it turns out that students who have kinesthetic and auditory learning styles tend to have a higher reduction in misconceptions. In other words, the ability to absorb the concepts presented by the teacher is higher for students who have kinesthetic and auditory learning styles, compared to students who have visual learning styles. This finding is also in accordance with the results obtained by Fajarianingtyas et al. (2018), Mufidah et al. (2018), and Ayuni et al. (2023).
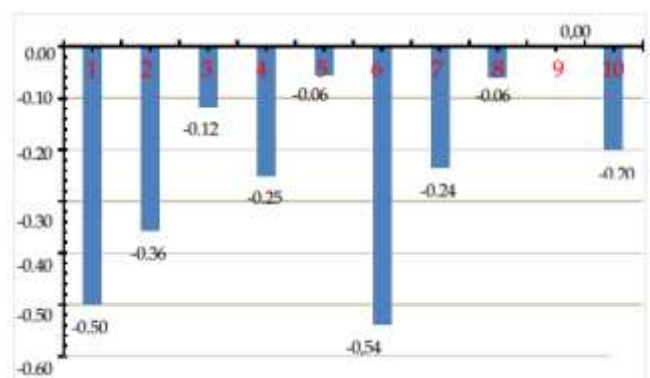

Figure 4. The reduction of misconceptions for each item

The topic of traveling waves, there are four indicators, namely the concept of travelling waves; the concept of formulate the traveling waves; the concept of relationship between variables in traveling waves; and the concept of phase angle, phase, and phase difference. The reduction of misconception in 10 items can be seen on Figure 4.

The questions of 1, 2, 3 included in the first indicator which discusses about the concept of travelling wave. Based on the data result, there was a decrease in misconceptions in identifying the characteristics of traveling waves, identifying traveling wave variables, and determining the direction of wave propagation. The questions of 4, 5, and 10 included in the second indicators about the concept of formulate the traveling waves. There was a decrease in misconceptions in formulate the traveling wave equation and and solve the cases with formulate the traveling wave. The questions of 6,7,8 included in the third indicator about Relationship between physical quantities of traveling waves. There was a decrease in misconceptions in. The question of 9 included in the fourth indicator about the concept of phase angle, phase, and phase difference. There is no decrease in misconceptions in question 9, meaning that the number of students' misconceptions before and after learning is the same. The number of decreases in student misconceptions based on questions on each indicator can be seen in Table 5.

Table 5. The Reduction of Student Misconception of Each Indicator

Indicators	Misconception		N-Gain
	Pretest	Posttest	
The concept of travelling waves	18	4	-0.31
The concept of formulate the traveling waves	14	6	-0.16
the concept of Relationship between variables in traveling waves	16	4	-0.26
The concept of phase angle, phase, and phase difference	4	4	-0.00

From the Table 5, it can be seen that indicator I experienced the greatest reduction in misconceptions, followed by indicator III, and indicator II. The fourth indicator did not decrease students' misconceptions. Based on the data result, the use of interactive learning media with Visual Basic for Application Excel spreadsheet can reduce student misconceptions on indicators 1, 2 and 3.

Analysis of Student's Misconception Sources

Based on the five-level diagnostic question in identifying students' misconceptions on traveling wave material, the fifth level is a statement about the source of understanding possessed by students in answering the question. This source can be the answer to where students' misconceptions come from. The sources of understanding include, teacher explanation; Student thoughts; books; and friends. From the analysis of students' answers, the sources of students' misconceptions on the traveling wave material are shown in Table 6.

Table 6. The Result of Misconception Source

Misconception Source	Pre-test (%)	Post-test (%)	Total (%)
Teacher Explanation	2.2	23.3	12.8
Student Thoughts	64.3	56.3	60.3
Books	16.1	7.1	11.6
Friend	8.7	4.6	6.6

Table 6 shows that the source of students' misconceptions comes from students' own thinking. The total percentage of the students' own thinking category is 60.3%. According to Suparno (2013), misconceptions come from students' preconceptions. Preconceptions are initial concepts about a material before students take formal lessons under the guidance of a teacher. These initial concepts often contain misconceptions that often cause misconceptions. These preconceptions are usually obtained from parents, friends, early schooling, and experiences in the student's environment.

Analysis of the Effect of Using Interactive Learning Media Based on Visual Basic for Application Excel Spreadsheet

Analysis of the Effect of using interactive learning media based on visual basic for application excel spreadsheet to reduce students' misconception in traveling wave includes normality test and hypothesis test. The normality test determines whether the research data is normal (Malik et al., 2022). The normality test in this study was carried out on the pretest and post-test results using the Shapiro-Wilk test with a significance level (a) of 0.05.

Based on the results of the normality test of pre- test data and post-test data, the T3 test value is 0.920 and 0.928, where this value is greater than the value of the normality test table at a significant level of α 0.05, which is 0.908. If the T3 test value > 0.05 then the pre-test data and post-test data are normally distributed. Because both data are normally distributed, the next step can be used paired t-test to see the effect of using interactive learning media based on Visual Basic for Application Spreadsheet Excel in reducing students' misconceptions on traveling wave material. The paired t-test was obtained with the help of Data Analysis Microsoft Excel which is indicated by Table 7.

Table 7. The Result of Paired t-test

T-Test: Paired Two Sample for Means		
	Pre-test Value	Post-test Value
Mean	24.28571429	66.19047619
Variance	225.7142857	284.7619048
Observations	21	21
Pearson Correlation	0.58038839	
Hypothesized Mean Difference	0	
Df	20	
t Stat	-13.0603479	
P(T<=t) one-tail	0.00000000001501	
t Critical one-tail	1.724718243	
P(T<=t) two-tail	0.00000000003002	
t Critical two-tail	2.085963447	

Based on the output of the Data Analysis Excel test, it is known that P (T <=t) (two-tail) is 0.0000. These results meet the requirements of hypothesis testing, namely Aysimp.Sig <0.05 with the conclusion that the Ha hypothesis is accepted. This means that the use of interactive media based on Visual Basic Spreadsheet Excel has a significant effect in reducing student misconceptions on traveling wave material.

Several previous research results related to efforts to reduce misconceptions in physics learning have been carried out. These include remediation of Newton's laws using experimental methods (Zulvita et al., 2017), remediation of modern physics concepts with e-learning modules (Halim et al., 2020), remediation of electricity concepts with PhET and Lectora simulations (Putra et al., 2016), remediation of electrical concepts using experimental methods (Tarmizi et al., 2017), and remediation of Newton's laws with comic-based E-modules (Mukramah et al., 2023).

Conclusion

Based on the study's results, it can be concluded that interactive learning media based on Visual Basic for Application excel spreadsheet is feasible to use in physics learning with the value of validity and reliability of Aikens index and Inter-Rater Agreement 0.8 and 0.85. The results of identifying students' misconceptions on traveling wave material during pretest and posttest, it can be concluded that there is a decrease in the percentage of students' misconceptions from 28.5% to 11.4%. Then, Interactive learning media based on Visual Basic for Application (VBA) spreadsheet excel has a significant effect in reducing students' misconceptions in learning physics, especially the material of traveling waves. the significance value is smaller than α = 0.05, which is 0.000. This shows that the hypothesis is accepted, meaning that the use of interactive learning media based on Visual Basic for Application (VBA) spreadsheet excel can remediate students' misconceptions on the material of traveling waves. The limitation of this research is that the interactive learning media developed through the Visual basic for Application excel spreadsheet feature can only be opened through the window operating system. So, the researchers suggest that interactive learning media be developed that can be accessed on all devices.

Author Contributions
The lead author, R.Z; contributed to designing and conducting the research and writing the article. The second and third author, A.H and I.K; contributed in guiding the writing of the article to completion. The fourth, fifth, and sixth, E.M, MN, E.K; contributed to validate the instruments of the article. All authors have approved the version of the manuscript to be published.

Conflicts of Interest
There is no conflict of interest in this research.

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