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The Effect of Using Comic-based E-Module Assisted by the Flipbook Maker for Remediation of Newton's Law Misconceptions

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Abstract: Misconceptions are seen as a learning barrier because they hinder students from learning and understanding new concepts. Misconceptions about mastering physics concepts occur in Newton's Laws. The language that is difficult to understand and errors in writing are some of the causes. To overcome those problems, this study aims to use a comic-based e-module assisted by a flipbook maker to remediate misconceptions about Newton's Laws. The research method is a pre-experimental design, with one group for pre-test and post-test. A total of 22 samples were selected based on the purposive sampling technique. The data were collected twice during the pretest and post-test using a three-tier multiple-choice diagnostic test consisting of 20 items. The analysis of misconception remediation indicates a decrease in misconceptions from 57.01% to 20.24%, with an N-Gain score of 0.71. This implies a significant reduction of misconceptions before and after treatment. This data is also supported by the results of the Wilcoxon test analysis, that is, 0.000<0.5, which means that the use of comic-based e-module significantly affects the remediation of students' misconceptions of Newton's Law material. This e-module is expected to be an alternative for teachers in remediating misconceptions in learning physics.

Keywords: Comics; E-module; Flipbook maker; Misconceptions; Newton's laws

Introduction

Misconceptions have been recognized as a barrier to learning (Kibirige & Mamashela, 2022). This is because misconceptions can hinder students from learning and understanding new concepts (Bekkink et al., 2016). The concepts of force and Newton's laws are the basis for studying other complex concepts in physics (Wancham et al., 2023). This concept is also a core concept in STEM education, and students must have a good understanding without misconceptions to study effectively in this field (Abdurrahman et al., 2019; Fathurohman et al., 2021). In addition, the concept of force and Newton's laws are essential in explaining the physical phenomena that people experience in everyday life (Aygün & Mustafa, 2021), for example, illustrating the relationship between the motion of an object and the force acting on it (Sundaygara et al., 2021).

Various research on misconceptions, especially on Newton's law, has been studied since the 80s' (David & Clement, 1987) through three main stages (Halim, Soewarno, et al., 2020), that is (1) development of diagnostic test instruments (Eryilmaz, 2002; Halim, et al., 2020; Handhika et al., 2018; Licht & Thijs, 1990;

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Saayman, 1997; Turker, 2005; Mufit & Syamsidar, 2022; Wancham et al., 2023); (2) identification and analysis of the causes of misconceptions (Zhou et al., 2015; Sulistri & Lisdawati, 2017; Yuberti et al., 2020; Rusilowati et al., 2021; Huda et al., 2022), and (c) remediation of misconceptions (Gisev et al., 2013; Pratama et al., 2021).

Throughout the history of research on misconceptions among students, various attempts have been made with multiple learning activities, including using analogical bridges to connect problems in learning (David & Clement, 1987) and involving cognitive conflict (Syahrial et al., 2023) because the stages of cognitive conflict learning emphasize students' conceptual changes, from the wrong initial concept (misconception) to the correct concept (Pratama et al., 2021). Furthermore, conceptual change text is also used to overcome misconceptions (Djudin & Yuragi, 2023) by changing the understanding of the concept from a less scientific conception to a scientific conception (Kistiono et al., 2017). Several studies have also used educational comics to assist students' analogies to replace students' misconceptions with scientific truths (Fathurohman et al., 2021; Hesti, 2021; Norma et al., 2021), and the subsequent effort that has been used since the 80s' is a computer simulation (Finegold & Gorsky, 1988), the results of computer-aided simulations effectively reduce students' misconceptions about optical concepts (Kaniawati et al., 2020).

Based on the efforts to remediate the misconceptions above, the teacher must first conduct a need analysis of students and their learning activities to find out what actions can help overcome misconceptions (Pratama et al., 2021). Based on the need analysis, it was found that misconceptions occur due to textbooks. The use of language that is difficult to understand, abstract concepts, and errors in writing are the major causes that lead to misconceptions. This problem also occurs in research conducted by (Ginting et al., 2022), where the leading cause of misconceptions is textbooks, with a percentage of (21.38)%, which is the largest category compared to other reasons. Not only that, research by (Yolviansyah et al., 2022) also identified the particular causes of misconceptions that occur in textbooks, such as the presentation that is less interesting to read, language structures and material descriptions that are difficult to understand, as well as graphic and image representations that are complicated to comprehend.

Therefore, based on the explanation of the problems above, this study aims to implement an effort to remediate misconceptions by using a comic-based e-module on the concept of Newton's Law. This effort has several advantages, including the fact that the e-module is already assisted by the flipbook maker so that it can contain simulations, learning videos, YouTube and feedback after answering tests (Halim, Soewarno, et al., 2020; Mukramah et al., 2020). As a result, the book's presentation is more interesting and easy to understand (Fathurohman et al., 2021; Nurfazliana & Jumadi, 2023). Furthermore, integrating comics within the e-module-assisted by the flipbook maker can increase scientific literacy (Nurharini et al., 2022), learning achievement (Chamisijatin et al., 2020), and remediation of misconceptions (Hesti, 2021).

Method

This study used a quantitative approach with a pre-experimental method with one group pretest and post-test design. According to (Ma et al., 2019), a pre-experimental design is a design that includes only one group or class that is given a pretest and post-test. This one-group pretest and post-test design were carried out on one group without a control or comparison group (Wulandari & Purwani, 2021).

The research subjects were selected using a purposive sampling technique. There were 22 students from class VIII A at Al-Mujaddid Sabang Islamic Middle School. The instrument used was a three-tier multiple-choice diagnostic test consisting of 20 questions with reasoning and confidence levels. The test questions were developed from research (Deviani, 2018; Nasafi, 2018; Ramadhanty, 2018; Nadila, 2020). The test item instrument was assessed 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. Besides, all item items have been tested empirically. Based on validity and reliability analysis, difficulty level, and discriminating power, it is concluded that four items were discarded from the 24 items tested. Thus, only 20 questions were accepted and suitable for use according to the criteria (Utomo, 2019).

Data was collected using a three-tier multiple-choice diagnostic test at the pretest and post-test. The pretest was given to students studying Newton's Laws in the initial stage. After that, the students were given the opportunity to use the e-module for four meetings supervised by the teacher and in the final stage, the post-test was carried out. The students' answer patterns were identified into three categories, that is: (1) mastering the concept; (2) misconceptions; (3) do not master the concept, with interpretations as shown in Table 1.

Furthermore, data analysis was done using Excel, the N-Gain test and non-parametric statistics, and the Wilcoxon test to measure the significance of the difference between two groups of paired data-the pretest and post-test (Refugio, 2018).

Table 1. Interpretation of Student Responses

Tier 1 (Conception)	*Tier* 2 (Reason)	*Tier* 3 (Confidence Level)	Category Interpretation
Correct	Correct	High (>2.5), very confident	Mastering Concepts
Correct	Wrong	High (>2.5), very confident	Misconceptions
Wrong	Correct	High (>2.5), very confident	Misconceptions
Wrong	Wrong	High (>2.5), very confident	Misconceptions
Correct	Correct	Low (≤ 2.5), not sure	Not mastered the concept
Correct	Wrong	Low (≤ 2.5), not sure	Not mastered the concept
Wrong	Correct	Low (≤ 2.5), not sure	Not mastered the concept
Wrong	Wrong	Low (≤ 2.5), not sure	Not mastered the concept

Result and Discussion

The three-tier multiple-choice diagnostic test on the concept of Newton's Law was given to experts for validity and reliability tests and to be tried on a limited sample. The results from the experts indicated that 24 items were in the very proper category, which means that they can measure the formulated indicators, are conceptually correct, and do not cause ambiguity. Furthermore, the validity test results on the three-tier multiple-choice diagnostic test items on Newton's Law concept obtained 20 valid items and four invalid items, with the instrument validity obtained r_{xy} = 0.67 with a reliability coefficient or Cronbach's Alpha of 0.908. Therefore, it is concluded that 20 items have a high correlation between items and can be used for measurement. These items can measure the students' level of misunderstanding of concepts in Newton's Law material (Ningsih et al., 2022; Rizki & Setyarsih, 2022; Wahyuningasri & Ambarwati, 2022).

Results of E-Module Validity and Reliability Test

The results of the validity test, using the Aiken Index, and the reliability test, using the Inter-Rater Agreement (IRA), on the comic-based e-module assisted by the flipbook maker on Newton's Law concept can be seen in Table 2. Based on Table 2, the results of calculating the Aiken index for the media category is 0.96, and for material is 0.8., with an average score of 0.88. Based on the assessment results by experts who have calculated using the Aiken index, it can be concluded that the media and materials used in the e-module are valid. This suggests that the e-module is very feasible to use in order to overcome misconceptions about the concept of Newton's Law. Furthermore, the calculation result from the Inter-Rater Agreement (IRA) for the media category is 0.79, and for the material category is 0.8, with an average score of 0.795. The results of this average score indicate that the level of agreement from experts on the statement of items that are assessed is not coincidental (Excellent agreement beyond chance) (Shweta et al., 2015). The validation technique and validation results are not significantly different from the research conducted by (Pratama et al., 2021).

Table 2. Validity and Reliability of Comic-Based E-Module Assisted by the Flipbook Maker

Category	Aiken Index	Validity Standard	Inter-Rater Agreement (IRA)	Reliability Standard
Media	0.96	Valid	0.79	Excellent agreement beyond chance
Material	0.80	Valid	0.80	Excellent agreement beyond chance
Average	0.88	Valid	0.795	Excellent agreement beyond chance

The Implementation of a Comic-based E-Module Assisted by the Flipbook Maker

The Flipbook Maker software assists with the e-module used in this study. The e-module contains material presented in the form of comics, learning videos, simulations, and 30 practice questions. The presentation of material in the e-module uses language that students easily understand. It is in the form of teacher and student conversations, as displayed in Figure 1 and Figure 2. Similar to research by (Yolviansyah et al., 2022), based on the need analysis, language can cause misconceptions. The use of language that is difficult to understand, abstract concepts, and errors in writing are the causes of misconceptions.

Explanation of abstract concepts can be overcome using computer simulations (Halim, et al., 2020). According to (Kaniawati et al., 2020), computer simulations effectively reduce misconceptions in students. Therefore, the simulation on the e-module used is already computer-based.

A survey by Lo et al. (2022) on the value of using comics shows that comics have the potential to attract more students to learn science subjects, facilitate students' reading comprehension skills, and foster their interest voluntarily because of the visual-based narrative

approach used. Comics have an analogical approach that is packaged in a concept to adjust wrong conceptions and lead to analogical reasoning that activates a more profound understanding, thus shaping students' conceptions (Hesti, 2021). Based on the research by (Norma et al., 2021) related to the application of comics in learning, the results show that using comic media influences students' understanding of chemical bond concepts.

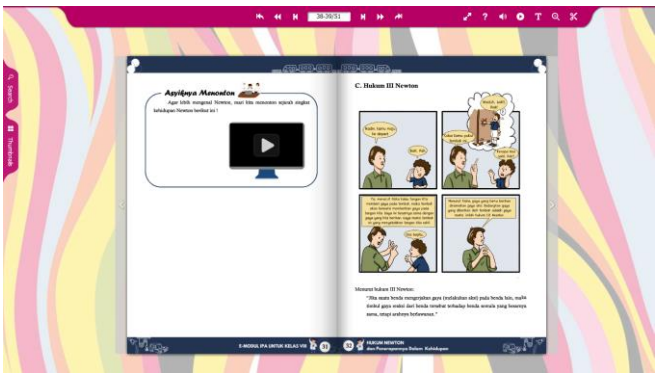

Figure 1. E-module display

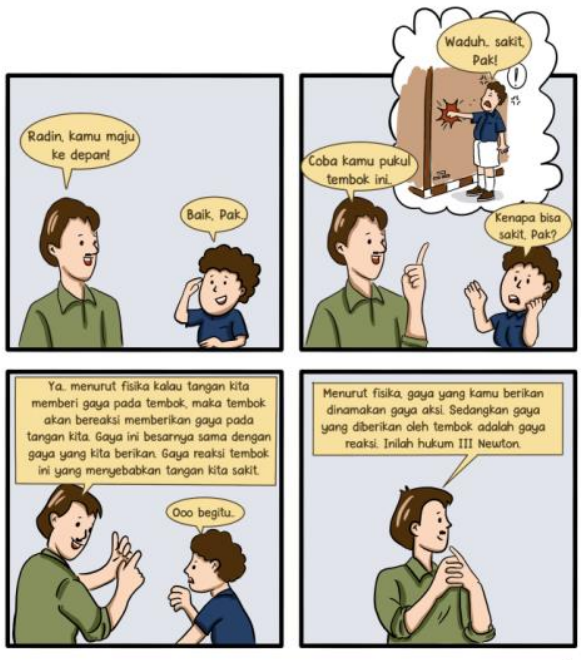

Figure 2. Comic-based e-module

Analysis of Newton's Law Misconceptions

The results of collecting data on students' misconceptions in this study used a three-tier multiple-choice diagnostic test consisting of 20 questions. There are 11 indicators used in this three-tier multiple-choice diagnostic test. Based on the results of the data analysis of misconceptions in Table 3, there has been a decrease in misconceptions for each indicator. However, the misconceptions still occur, only the percentage has decreased significantly. Indicator number three, about the explanation of Newton's First Law, experienced a decrease in misconceptions of up to 100%, similar to indicator number seven, about the calculation of Newton's Second Law. Based on Table 2, it can be seen that a significant decrease in misconceptions occurred in the cognitive domains from C1 to C4, implying that stimuli related to understanding concepts, formulas and calculations are useful for overcoming misconceptions. However, for the C5 cognitive domain, i.e., produced evidence, the percentage of reduced misconceptions that occurs is classified as low. This means that the stimulus related to tables of various activities regarding force is less helpful for students to understand the effect of force on the motion of an object.

Table 3 displays that using a comic-based e-module assisted by the flipbook maker on the concept of Newton's Law reduces students' misconceptions from 57.01% to 20.24%. The reduction of this misconception is further proven by calculating the N-Gain score.

Based on the results of the analysis of the pretest and post-test scores of 22 students, the average N-Gain score obtained was 0.71. These results indicate that a comic-based e-module assisted by the flipbook maker can reduce students' misconceptions of Newton's Law and improve their learning outcomes. The N-Gain scores obtained can be seen in Table 4. Meanwhile, the average N-Gain scores for 22 students can be seen in Figure 3.

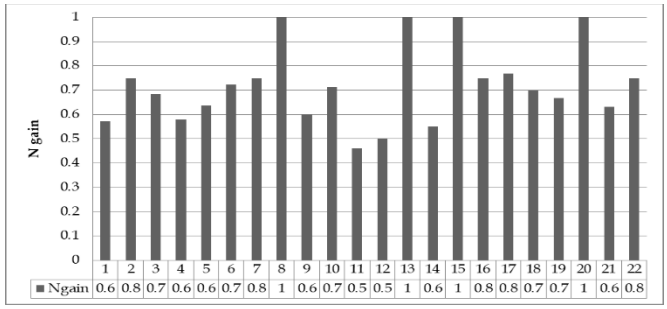

Figure 3. The obtained n-gain score

The graphical data in Figure 3 is the N-Gain data for the sample in this study. Based on the figure above, it is known that students with the high N-Gain category are students in the following order: 2nd, 8th, 15th, 16th, 17th, 20th, and 22nd. Meanwhile, students with the moderate N-Gain category are 1st, 3rd, 4th, 5th, 6th, 7th, 11th, 12th, 14th, 18th, 19th, and 21st.

The occurrence of an increase in student learning outcomes before and after the use of the comic-based e-module assisted by the flipbook maker on the concept of Newton's Law is in line with research conducted by (Arzak & Prahani, 2023), where the results of the study show that students are more interested and better understand the material by learning using computer-

based e-modules due to many simulations that can be loaded there.

Meanwhile, based on the results of the analysis of misconception data on the 20 items, the average N-Gain score obtained was 0.59. These results indicate that a comic-based e-module assisted by the flipbook maker can reduce students' misconceptions about Newton's Law concepts. The average N-Gain score is displayed in Table 5, and the N-Gain score for each item can be seen in Figure 4.

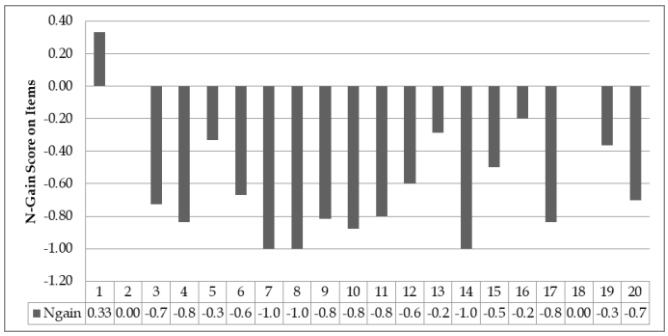

Figure 4. The obtained n-gain score on item

The graphic data in Figure 4 is the N-Gain score of misconceptions for each item. Based on the graph above, the N-Gain score has neutral, positive, and negative values. The N-Gain score is neutral for questions two and 18, which are in the C1 cognitive domain. The N-Gain score is negative for questions 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 19, and 20 which are in the cognitive domain from C2 to C4. While the N-Gain score for question number one, which is in the C5 cognitive domain, is positive. This suggests that remediation of misconceptions using a comic-based e-module assisted by the flipbook maker is only useful for the category of misconceptions in the cognitive domains from C1 to C4. For example number three, which explains Newton's First Law, students only need to understand the core concept of Newton's First Law and its equations, so the knowledge students must have to answer this question lies in the domain of C2, i.e. understanding.

Regardless of the positive N-Gain score obtained, the concept in question number 1 about force is still misunderstood by students. This means that the remediation applied to the e-module is still ineffective, especially for the concepts that require further explanation and proof. Therefore, to overcome this, teaching and learning can be combined with conventional understanding (Halim, et al., 2020), called blended learning (Rasheed et al., 2020) or direct learning assisted by interactive multimedia (Malik et al., 2022).

Table 3. Recapitulation of the Percentage of Misconceptions on Indicators

Indicator	Question item	Pre-test (%)	Post-test (%)
Investigate the effect of force on the motion of objects	5	27.30	18.20
Identify applications of Newton's First Law	6	13.60	4.50
Explain the concept of Newton's First Law	2	4.50	0.00
Analyzing events that apply the concept of Newton's First Law	1, 3, 4	104.50	36.40
Identify the application of Newton's Second Law	9	50.0	9.10
Explain the concept of Newton's Second Law	7, 11, 12	95.50	13.60
Calculation of Newton's Second Law	8	27.30	0.00
Analyzing events that apply the concept of Newton's Second Law	10	36.40	4.50
Identify applications of Newton's Third Law	15, 16	59.10	36.40
Explain the concept of Newton's Third Law	14, 18	54.50	27.30
Analyzing events that apply the concept of Newton's Third Law	13, 17, 19,20	154.50	72.70
Average		57.01	20.24

Analysis of the Effect of Using E-Module for Remediation of Misconceptions

Testing the research hypothesis was conducted to determine the significance of differences in increasing learning outcomes and reducing students' misconceptions about Newton's Law concepts. The steps for testing the hypothesis consist of a normality test and a 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 (α) of 0.05. The calculation of normality test results can be seen in Table 4.

Table 4. Normality Test Results

	Tests of Normality					
	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistics	df	Sig.	Statistics	df	Sig.
Pretest	0.15	22	0.20	0.91	22	0.05
Post-test	0.14	22	0.20	0.93	22	0.10

Based on the results of the normality test in Table 4, it was found that the sig value obtained at the pretest was smaller than the sig level (<α), i.e., 0.048 < 0.05, so the data was not normal. Furthermore, the sig value obtained in the post-test is more significant compared to the sig level (>α), i.e., 1 > 0.05, so the data is normal. Due to one of the data not being normally distributed, then the non-parametric statistical test was carried out.

In addition, the hypothesis test used the Wilcoxon test. This hypothesis test aims to determine whether this study accepts or rejects the hypothesis. The results of hypothesis testing are shown in Table 6. Meanwhile, Table 5 is a rank table to determine the negative and positive ranks on the Wilcoxon test. Negative ranks marked with a letter (a) indicate the number of respondents in the rank of post-test scores that are smaller than the pretest, while positive ranks marked with letters (b) show that the number of respondents in the rank of post-test scores is greater than the pretest, and the marked with the letter (c) indicates the number of respondents at the same rank, i.e., the post-test score is the same as the pretest.

Table 5. Wilcoxon Signed Ranks Test

	Ranks	N	Mean Rank	Sum of Ranks
Posttest–Pretest	Negative Ranks	0[a]	0.00	0.00
	Positive Ranks	22[b]	11.50	253.00
	Ties	0[c]		
	Total	22		

The results of the rank analysis in Table 7 show that the number of negative ranks is 0, the positive ranks are 22, and the ties are 0. This means the 22 students have a post-test score greater than the post-test. Furthermore, the decision to test the hypothesis can be seen from the Wilcoxon Asymp.Sig (2-tailed) test value in Table 8.

Table 6. Wilcoxon Test Results

Test Statistics	Post-test – Pretest
Z	-4.11
Asymp. Sig. (2-tailed)	0.00

Based on Table 8, the decrease in students' misconceptions has a significant value smaller than α = 0.05, which is 0.00. This shows that the hypothesis is accepted, meaning that the use of an e-module assisted by the flipbook maker significantly affects the remediation of students' misconceptions about Newton's Law. Thus, an e-module assisted by the flipbook maker can facilitate concepts that are difficult to understand with simulations inside (Mukramah et al., 2020). Meanwhile, the comic-based e-module can improve concepts mastery and creative thinking (Fadhila & Widodo, 2019), learning outcomes (Chamisijatin et al., 2020), and remediation of misconceptions (Purwasih et al., 2020).

Conclusion

Based on the study's results, it can be concluded that overall, the students' misconceptions regarding Newton's Law concepts can be overcome by using a comic-based e-module assisted by the flipbook maker. The use of this e-module is effective for concepts that are difficult to understand because of the use of very complex language. However, this e-module is less appropriate for understanding the material that requires evidence. Suggestions for further e-module development are to include a virtual lab to facilitate students in conducting experiments to produce evidence.

Author Contributions

The lead author, Widya An Nisa Mukramah, contributed to designing and conducting the research and writing the article. The second and third author, Abdul Halim and Sri Winarni, contributed in guiding the writing of the article to completion. The fourth, fifth, sixth, and seventh author, Yusrizal, Safrida, Misbahul Jannah and Agus Wahyuni contributed to validate the instruments of the article. All authors have approved the version of the manuscript to be published.

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Conflict of Interest

There is no conflict of interest in this research.

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