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Development of E-module on Particle Motion Dynamics Topics using Heyzine Flipbook for 11th Grade Students

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Abstract

The purpose of this study is to determine the development of an e-module on the material of particle motion dynamics for 11th grade students and to assess the feasibility of the e-module on the material of particle motion dynamics for 11th grade students. This research is developmental research using the Research and Development R&D procedure according to Borg and Gall. The instruments used in developing the e-module are validation instruments and e-module comprehensibility instruments. The validation results of the e-module from the content feasibility aspect obtained an average score of 3.54 (very valid), the media feasibility aspect 3.57 (very valid), and the language feasibility aspect 3.68 (very valid), with a reliability level above 80%. The resulting e-module is easy for students to understand. This is evident from the e-module's comprehensibility test, which had an average score of 87.6%, placing it in the high category. The research results show that the e-module on particle motion dynamics for 11th-grade students that was developed is categorized as very feasible to use. The average feasibility percentage for the e-module is 91%, placing it in the very feasible category.

Keywords: e-module, heyzine flipbook, particle motion dynamics

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INTRODUCTION

Physics is a branch of natural science that plays an essential role in explaining natural phenomena through principles, concepts, and physical laws. Many modern technologies are applications of physics concepts, including digital communication devices, transportation systems, and various electronic equipment (Fishbane et al., 2005). Therefore, a deep understanding of physics concepts is required for students in order to compete in the digital era. However, there are still several challenges in physics learning at schools, one of which is students' difficulty in understanding particle dynamics. This topic is often considered difficult by students because concepts such as mass, acceleration, force, and Newton's laws of motion are perceived as abstract (Weber & Wilhelm, 2024). Understanding particle dynamics requires not only conceptual comprehension but also reasoning and mathematical skills. As a result, many students experience difficulties in solving problems related to this topic (Docktor & Mestre, 2014).

One of the contributing factors to these difficulties is the limited use of interactive learning media, which makes it harder for students to relate physics concepts to real life phenomena (Alstein et al., 2023; Rutten et al., 2012). In fact, connecting theoretical concepts with real-world contexts is crucial for developing meaningful understanding. Along with the rapid advancement of information and communication technology, the education sector is required to adapt by utilizing technology as a supporting tool in the learning process. The integration of technology in education has been proven to enhance both the quality of learning processes and outcomes, particularly through the use of interactive digital media (Cheung & Slavin, 2013; Hillmayr et al., 2020; Schmid et al., 2014; Zhao Ma et al., 2024). One of the instructional innovations that can be developed is the use of e-module.

E-modules are digital media in the form of teaching materials designed in an attractive and systematic manner, containing materials, methods, and evaluations that can be applied on a personalized basis in the learning process (Al Mamun & Lawrie, 2023). E-modules have advantages, including increasing learning efficiency because they can be accessed online without being bound by space and time, motivating students, being more interactive and dynamic than printed textbooks, and presenting visual elements with videos (Al Mamun & Lawrie, 2023; Fiorella & Mayer, 2018; Mayer, 2003; Siantuba et al., 2023; Sung et al., 2016). Creative innovation is needed from teachers to design a learning process that is engaging and tailored to student characteristics. The solution requires teaching materials as a good conveyor of information to assist students in learning (Al Mamun & Lawrie, 2023; Maulisa et al., 2024; Ramadannisa et al., 2025).

The develope e-module, Canva is used as an application for the design and arrangement of material presentation, while Heyzine is used as a publication medium in the form of an interactive flipbook. The combination of these two applications presents the e-module digitally, visually appealing, and easily accessible to students via devices such as laptops or phones. Canva is a graphic design program that offers various editing tools to create different types of designs, including posters, flyers, infographics, and others (Canva, n.d.). One of the websites that can be integrated with Canva is Heyzine Flipbook. Heyzine Flipbook is an online platform that allows users to convert PDF documents into interactive digital publications like real books. With its superior features, Heyzine provides a more engaging reading experience (Heyzine, n.d.). The features available on Heyzine Flipbook include adding links, images, videos, audio, and web elements, which can be integrated into e-modules, making the e-modules more interactive and attractive.

The observation conducted public senior high school Ternate City shows that some students still experience difficulties in understanding the material on particle motion dynamics due to passive teaching methods, which make students feel bored and lose interest in learning. Based on interviews with subject teachers, the teaching materials used are lesson plans (RPP). When delivering the material, teachers must observe the classroom situation and conditions so as not to appear passive during the learning process. The main obstacle faced is the low interest of students during lessons because the delivery of material is still dominated by lecture methods and textbooks. Based on the explanation above, it is necessary to develop a physics e-module on particle dynamics material, with the aim of improving the quality of physics learning by facilitating students in achieving a deeper and more meaningful understanding of particle dynamics concepts.oriented instructional materials that support students' conceptual understanding, creativity, collaboration, and authentic problem-solving skills.

METHOD

The research used the Research and Development (R&D) method with the Borg & Gall model (Gall et al., 2003), which was modified into five stages: (1) preliminary study, (2) planning, (3) product development, (4) testing, and (5) product revision. The research steps in the development of this e-module are as shown in Figure 1.

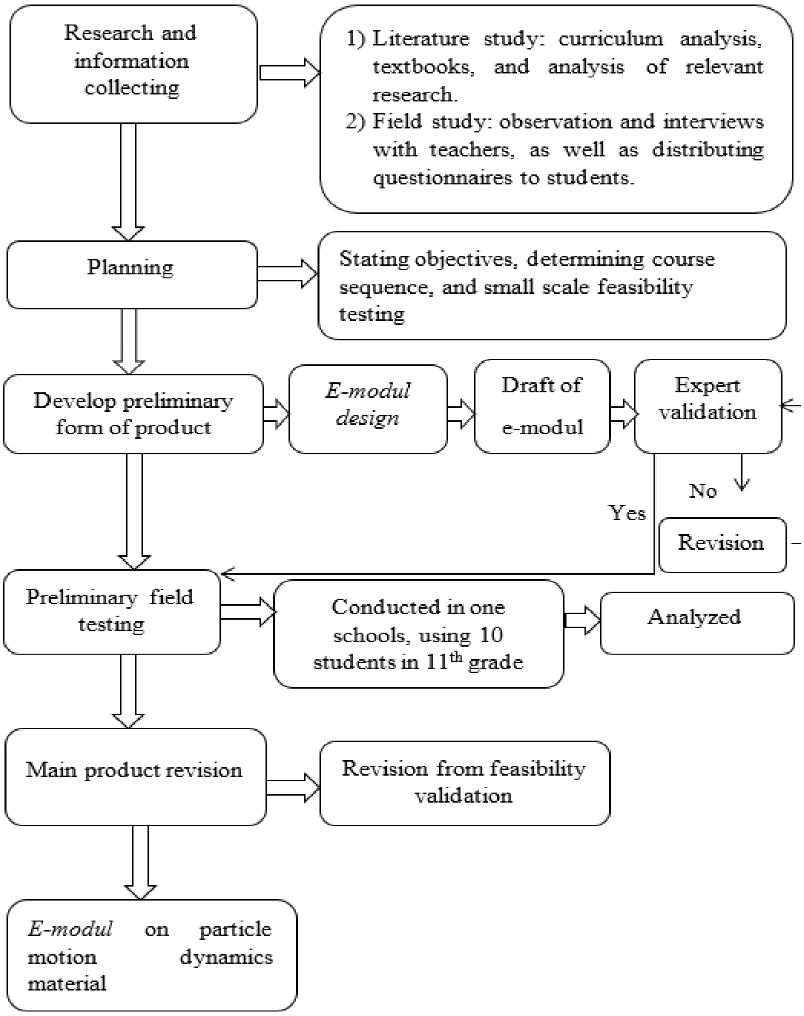


Figure 1. Research steps in the development of e-modules.

Preliminary study

a. Field study, conducted to determine the learning resource needs in high schools. The field study is carried out through analyzing the curriculum applied in the school, analyzing the students' developmental stages, and analyzing the availability of teaching materials in the field.
b. Literature study, This literature study is conducted to find all supporting information for the product to be developed, analyzing textbooks, journals, research articles, as well as e-modules that have been previously developed as a comparison.

Planning, planning to design the product to be developed

a. The purpose of developing the e-module is to provide an e-module according to the students' characteristics and learning styles.
b. The physics content to be developed is particle motion dynamics.
c. The instrument used in the research is the e-module validation instrument to measure the feasibility of the e-module.

Develop preliminary form of product

a. E-module design, which is arranging the structure and design of the e-module.
b. Draft of e-module draft, creating an initial draft equipped with material and video features.
c. Expert validation: at this stage, the researcher asks the validators to assess the product that has been developed. Validation testing is carried out to see the feasibility of the developed e-module involving 5 validators, namely 3 lecturers and 2 high school teachers, by providing an e-module validation instrument consisting of content feasibility components, display feasibility components, and language feasibility components.
d. Product revision, which is correction according to the validator's input.
e. The final product of this development is an e-module on the material of particle motion dynamics that is feasible to use.

Preliminary field testing

This field testing was conducted on a small scale with 10 students of 11th at one of public senior high school Ternate City. It aimed to assess the readability of the e-module. This stage was carried out by providing the produced product to the students to study, and then the students were asked to fill out an instrument to test the understanding of the e-module.

Product revision stage

After the trial was conducted, the e-module draft was then revised according to the suggestions provided by 5 experts. After the revision process, the e-module on particle motion dynamics was produced.

The instruments used in the development of this e-module consisted of expert validation instruments, and instruments for understanding the e-module. The data analysis techniques used in this study were adjusted to the data obtained during the research.

Reliability test

The results of the e-module validation by experts were analyzed for reliability based on the inter-observer agreement obtained from percentage of agreement statistical analysis (R) (Borich, 1994). The e-module validation data is said to be reliable if the percentage of argument (R) statistic is above 75%.

$$R = \left[1 - \left\{\frac{A - B}{A + B}\right\}\right] X\ 100\%$$

With R is reliability coefficient of the validation sheet, A is highest score from five validators, and B is lowest score from five validators .

Validity

The data from the analysis of the average scores of each assessment aspect and the total average scores obtained from 5 experts were then tested for validity by referring to the criteria listed from Sudjana (2005) in Table 1.

Table 1. Criteria for e-module validation assessment

Score interval of assessment results	Category	Description
3.25< score ≤4.00	very valid	can be used without revision
2.50< score ≤3.22	valid	can be used with slight revisions
1.75< score ≤2.50	quite valid	can be used with quite a lot of revisions
1.00< score ≤1.75	invalid	cannot be used yet and still requires consultation

Comprehension Test

To measure the level of comprehension of the e-module developed in this study, a comprehension test was administered that assessed the main ideas of the discourse, supporting sentences for those ideas, unfamiliar words, and sentences that were difficult to understand. The data analysis of the comprehension test results is calculated using the following formula (Soamole et al., 2024).

$$P = \frac{f}{N}\ x\ 100\% \qquad (1)$$

With P is percentage, f is number of points obtained, and N is maximum number of points.

RESULTS AND DISCUSSION

The purpose of this research is to develop an e-module on the topic of particle motion dynamics and to determine the feasibility of the e-module on the topic of particle motion dynamics. The development process uses the 5 main stages of the Borg & Gall model.

Research and information collecting

Literature study

At this stage, the researcher conducted an analysis of the Merdeka curriculum, high school physics textbooks, as well as several previous studies relevant to the development of e-modules. From the analysis results of the title "Development of a STEM-Based Guided Discovery Learning Particle Dynamics E-Module to Improve Students' Conceptual Understanding and Collaboration Skills," the developed e-module achieved a validation score of 3.25, which falls into the very good category. The developed e-module effectively improved conceptual understanding with an effect size of 1.29, which is categorized as high. All aspects showed an agreement level above 70%, so that all aspect assessments are reliable (Nafiyanto & Pebriana, 2023). particle dynamics material. Therefore, particle motion dynamics material is one of the subjects considered difficult by students because it is abstract and requires conceptual understanding. In addition, the teaching materials used in schools are still limited to textbooks and student worksheets. Therefore, teaching materials in the form of digital-based e-modules are needed that can visualize concepts through text, images, and learning videos that contain animations as well as practice questions to help students' understanding. This literature study was conducted to gather all supporting information for the product to be developed, analyze textbooks, journals, research articles, as well as e-modules that have been previously developed as a rerence material.

Field study results

Based on observations and interviews with 11th-grade physics teachers at the school, information obtained from the interviews indicated that students tend to be passive and less interested during learning. Most students have mobile phones/laptops that can be used to access the e-module. After conducting preliminary analysis and based on field observations, the researcher selected public senior high school Ternate City as the research subject for the topic of dynamics. particle motion. Based on field studies, the researcher developed a Canva-based e-module for learning about particle motion dynamics.

Planning stage

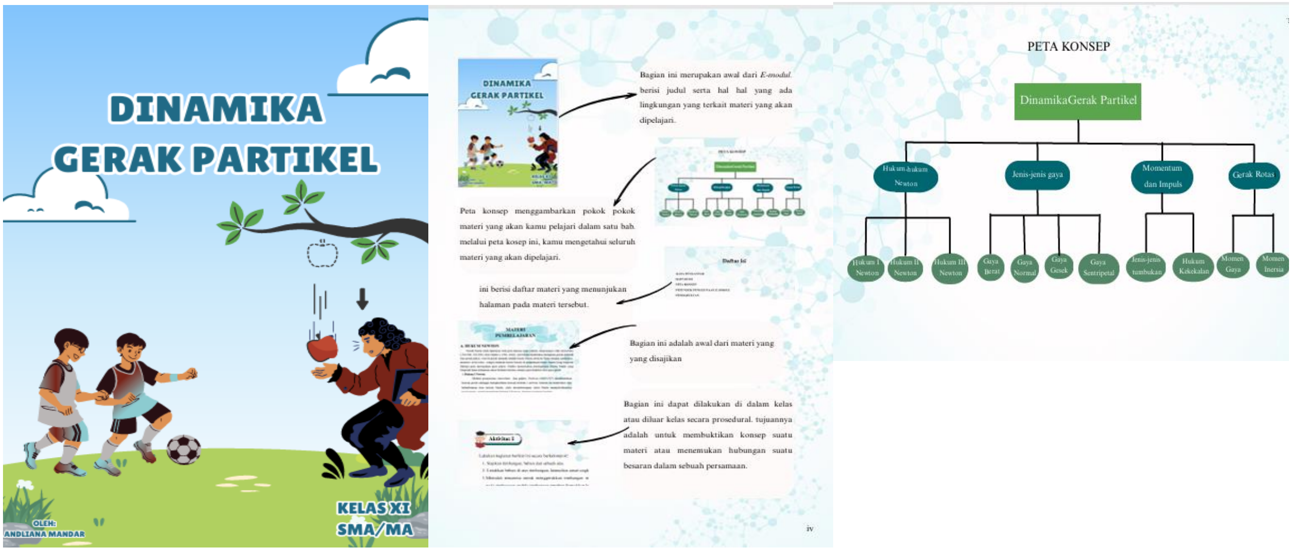
This stage aims to produce an initial design of the e-module to be developed. Some activities carried out in this stage include preparing the e-module draft. The researcher prepares the initial draft of the e-module using the Canva application. It is prepared by paying attention to the results of needs analysis and the characteristics of high school students. The structure of the e-module consists of cover page, foreword, user instructions, concept map, learning objectives flow, learning materials, examples, practice questions, references.

Develop preliminary form of product

The development stage is carried out to produce an e-module product ready for testing and validation by experts.

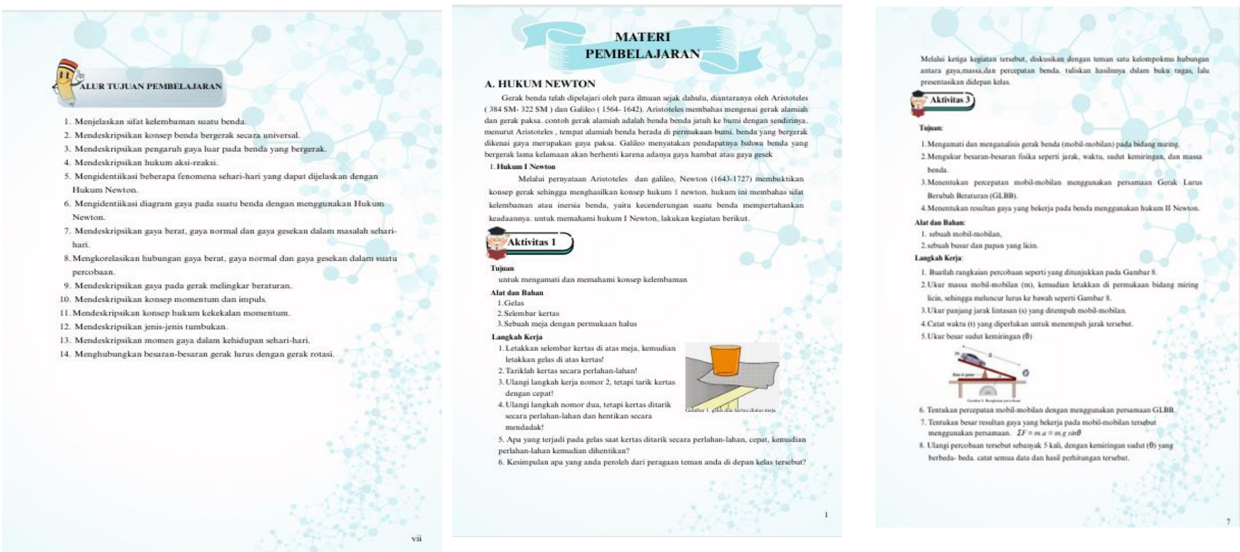
E-module creation

Based on the prepared draft, the researcher begins creating the e-module in Canva, then converts it to PDF and uploads it to the Hayzine Flipbook application. This e-module includes text, images, instructional videos, examples, and practice questions. The design is simple and easy for students to access, with videos, examples, and practice questions. The design is simple and easy for students to access.



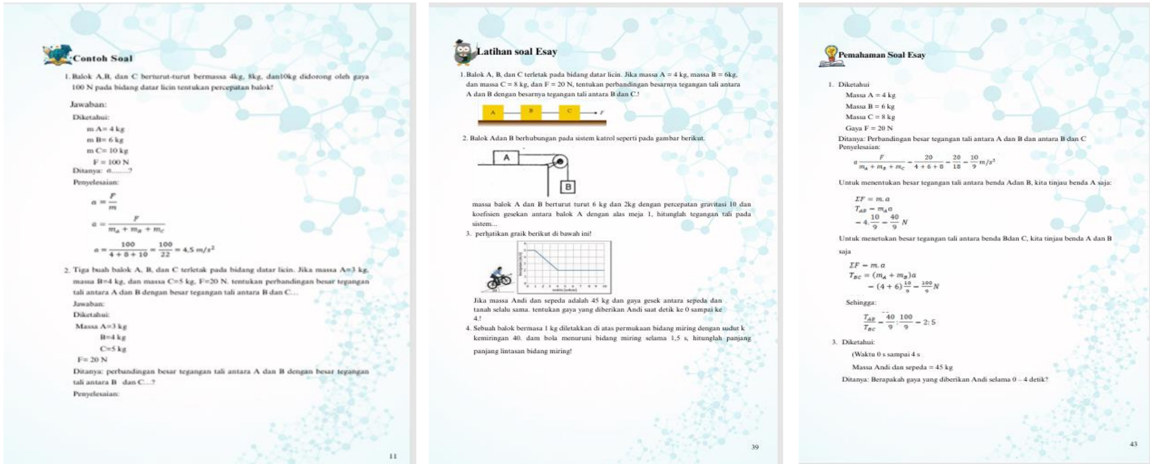
(a) (b) (c)

Figure 2. Module introduction: (a) Cover, (b) Instructions for use, (c) Concept map



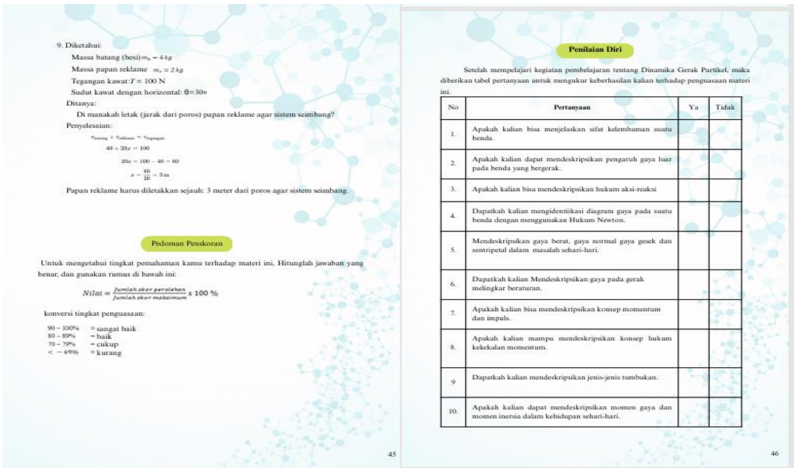
(a) (b) (c)

Figure 3. Module content: (a) Learning objectives, (b) Newton force (c) Activity student



(a) (b) (c)

Figure 4. Exercise in e-module: (a) Problems example, (b) Questions, (c) Discussion questions



(a) (b)

Figure 5. Assessment in Module: (a) Scoring guidelines, (b) Self assessment

Validation Results

The e-module that has been prepared is then validated by 3 lecturers and 2 teachers. They assess the appropriateness of the material content, the correctness of the concepts, and evaluate aspects of appearance, design, and ease of use.

Table 2. E-module assessment criteria

Assessed aspects	Validity Score	Validity	Reliability Score	Reliability
Content Feasibility	3.54	Very Valid	87.4%	Reliable
Media Feasibility	3.57	Very Valid	97.4%	Reliable
Language Feasibility	3.68	Very Valid	86%	Reliable

After the assessment was carried out, the validators provided input in the form of comments and suggestions for improvement. The researcher then revised the e-module based on the results of the validation to make the product more feasible for use.

Preliminary field testing

This stage is conducted to determine the students' understanding of the e-module. The limited trial was conducted with 10 eleventh-grade high school students who were the subjects of the study. After the e-module was revised based on the validation results from five validators, the e-module was then tested for comprehension by trying it out on the 10 high school students. The students' comprehension test was conducted using instruments that included: a) Test of writing the main ideas of the text, b) Test of supporting details for the main ideas, c) Words or terms in the text that were not yet recognized, d) And sentences that were difficult to understand in the text.

There are 10 passages in the e-module whose comprehension is tested. For the main idea of the passage, students are asked to first read the passage and then write down the main idea of each passage that has been presented. The results of the main idea test of the passages in the developed e-module can be seen in Table 3.

Table 3. Results of the main idea test of the passages

Discourse	Main idea	Average
Newton's First Law	93.34	High
Newton's Second Law	90.01	High
Newton's Third Law	93.34	High
Gravitational Force	86.68	High
Normal Force	80.02	High
Frictional Force	86.68	High
Centripetal Force	96.67	High
Momentum and Impulse	83.35	High
Torque	73.35	High
Moment of Inertia	93.34	High
Average total components	87.7	High

The results of the main idea test of the discourse presented in Table 3 show that the results of the analysis carried out on the main idea test for each discourse fall into the high category. The average percentage value for all components is also in the high category, with a value of 87.7%. Meanwhile, in the supporting sentence test of the main idea of the discourse, students were asked to read and then write down information that could support the main idea of each discourse. The analysis results of the supporting sentence test can be seen in Table 4.

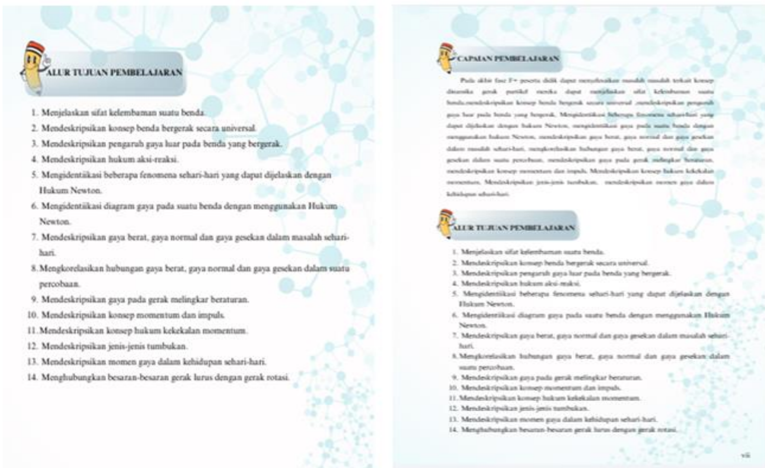
Table 4. Comprehension test of supporting main ideas of the discourse

Discourse	Average (%)	Criteria
Newton's First Law	77	high
Newton's Second Law	97	high
Newton's Third Law	93	high
Gravitational Force	87	high
Normal Force	90	high
Frictional Force	93	high
Centripetal Force	90	high
Momentum and Impulse	83	high
Torque	83	high
Moment of Inertia	83	high
Average total components	87.6	high

The results of the supporting sentence tests for the main idea of the discourse presented in Table 4 show that the results of the analysis obtained for each discourse fall into the high category. The average percentage value for all components is also in the high category with a value of 87.6%.

Main product revision

The research results obtained are then used as the basis for revising the e-module according to the recommendations provided by the validator team. The purpose of this product revision is to produce a quality product that meets the needs of students. Based on the improvement suggestions from the validators, the researcher then revises the e-module. The following is the appearance of the revised results.



(a) (b)

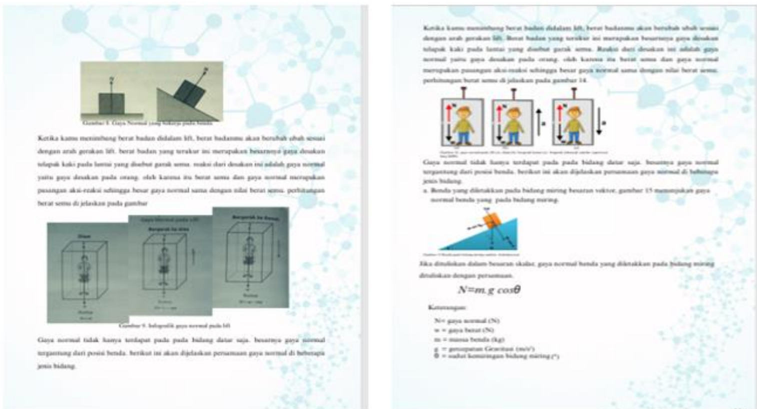
Figure 6. Module introduction revision: (a) Before revision, (b) After revision

In the figure 6 before revision (a) did not include the "Learning Outcome" (LO) recommended by the validator; include the LO so that improvements were made on the image on the right (b) which already includes the LO.

(a) (b)

Figure 7. Cover revision: (a) Before revision, (b) After revision

Figure 7 before revision (a) cover before revision did not describe the application of the concept of particle motion dynamics, whereas the cover after revision (b) uses more contextual illustrations such as the event of falling fruit and playing ball activities, thus depicting the concept of particle motion dynamics in a real and easily understandable way.



(a) (b)

Figure 8. Image revision: (a) Before revision, (b) After revision

In Figure 8 there is image revision, before revision (a) is larger in size and uses dark colors, making the appearance look unclear and pixelated, whereas the image after revision (right) has used brighter colors, making the appearance clearer and not pixelated.

CONCLUSION

The development of e-module on particle motion dynamics material using heyzine flipbook for 11th grade students used Canva application for the design and arrangement of material presentation, while Heyzine is used as a publication medium in the form of an interactive flipbook. The combination of these two applications presents e-module digitally, visually appealing, and easily accessible to students through devices such as laptops and mobile phones. Based on the validation results from the five validators, it was declared valid in terms of content feasibility at 3.54, which falls into the 'very valid' category, media feasibility at 3.57 in the 'very valid' category, and language feasibility at 3.68 in the 'very valid' category. The reliability of e-module in terms of content feasibility is 87.4% 'reliable', media feasibility 97.4% 'reliable', and language feasibility 86% 'reliable'. This e-module also has a level of understanding with an average percentage of 87.6% and falls into the high category. Besides that this e-module is very feasible to be tested on a larger scale because it has an average percentage value of 91% and falls into the 'very feasible' category.

STATEMENTS AND DECLARATIONS

Competing Interests. The authors declare no competing interests.

Author Contributions. Describe your author(s). AM contributed to the investigation, data collection, development of the e-module, data analysis, and preparation of the initial manuscript. DA contributed to the conceptualization, methodology, supervision, and review of the manuscript. M contributed to the methodology, supervision, data interpretation, and review of the manuscript. All authors read and approved the final manuscript.

Ethics Approval. The study was conducted in accordance with ethical principles for educational research. Permission to conduct the study was obtained from the participating school. The study involved validation of an educational product and a small-scale comprehensibility test with students.

Informed Consent to Participate. Participation in the study was voluntary. Informed consent was obtained from the participants and, where applicable, permission was obtained from their parents or legal guardians before data collection.

Consent for Publication. The authors consent to the publication of this manuscript. No personally identifiable information of the participants is included in the manuscript.

Data Availability. The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Use of Artificial Intelligence Tools. No OpenAI or other generative artificial intelligence tools were used in conducting the research, analyzing the data, or writing the manuscript. Grammarly was used only for grammar and language checking during manuscript preparation. All suggested language corrections were reviewed by the authors, who take full responsibility for the final content of the manuscript.

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