ScienceEdu: Journal of Science Education e-ISSN: 2685-2071
https://scienceedu.jurnal.unej.ac.id/index.php/Scedu/index

Development Of Digital Comic-Based E-Modules Through Canva Application For Class X Students Of Noemuti State Senior High School

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Article Info

Article history:
Received: May, 14, 2025
Accepted: May, 14, 2025
Published: June, 12 , 2025

Keywords:
Development, e-module, Digital Comic, Canva App

ABSTRACT

The study aims to describe the feasibility of electronic digital comic-based modules created through the Canva application for Grade 10 students of Noemuti State High School. This research was conducted at Noemuti State High School in August 2024. This research design follows to the *research and Development* (R&D) model of Thiagarajan, Semmel and Semmel consisting of four stages, namely: (1) *defining* (*define*), (2) planning (*design*) (3) development (*develop*) in the form of device validation and e-module media, and product trials involving biology teachers and students, and (4) *dissemination* (*disseminate*). The data collected in this development research include both qualitative data and quantitative data. Quantitative descriptive data analysis techniques were used to analyse data obtained from media expert validation sheets, material expert validation sheets, teacher assessment data and student assessment data obtained from questionnaires completed by respondents, regarding the feasibility of comic-based E-modules developed using the Canva application. The results of the validation from material experts and media experts at Stage I, namely material experts 76.25% and the results of validation from media experts are 78.94% indicating that the product met the feasible criteria. The results of the validation of material experts and media experts in Stage II, were 95.00% for material experts and 90.53% for media experts, meeting the criteria of "very valid" or "very feasible" for testing. The results of the biology teacher assessment trial yielded a score of 97.00% falls under the "very feasible" category. The results of the limited trial were 85.20%, while the small group trial achieved a score of 88% both meeting the "very feasible" feasibility criteria. Therefore, it can be concluded that the digital comic-based e-module developed is suitable for use as teaching material for students.

INTRODUCTION

Education is a conscious and structured effort aimed at creating an atmosphere and active learning process that helps develop the potential of students in terms of religious spirituality, self-control, personality, intelligence, and noble character, as well as the skills needed by themselves, society, nation and country. Fundamentally, education is an essential process in improving intelligence and skills, as well as strengthening the personality and sense of responsibility and realize their full potential. According to Indonesian Law No. 20 of 2003 concerning the National Education System, assessment in science literacy focuses on students' understanding of the scientific content, process and application of science (Yuliati, 2017). Biology learning, as a natural science, discusses all natural phenomena and includes four main components: product,

process, attitude, and application. This means that in the application of biology learning, there needs to be an effort to design biology learning to be interesting for students (Wedyawati & Lisa, 2019).

Based on the results of observations at Noemuti State High School, it was found that in reality, the application of the learning process in the field is still conventional. The lack of creativity of teachers and students in maximising the role of learning media has resulted in a decline in students' thinking skills. Observations show that the most commonly used learning media are visual-based materials, which lead to a less engaging and monotonous learning atmosphere, students seem bored and lack of enthusiasm with this less varied learning media. Teachers and students should be able to identify, compile, develop, and evaluate teaching materials, choose strategies, choose learning models and choose quality and creative learning media in an effort to achieve the learning objectives that have been set (Zulpar, et al., 2020). This aligns with Pian's research (2020), which highlights that so far teachers only give assignments in the form of questions where students write answers in notebooks without giving students the freedom to answer in different forms, for example, the assignment is collected in the form of videos, posters, presentation slides, songs, animated images or in other forms. This practice affects the implementation of the learning process, which should be adapted to current technological developments. Meanwhile, Yolanda's research (2020) describes the condition of learning in the digitalisation era. Given the rapid development of technology and information in this globalized world, it is undeniable that the world of education must adjust its influence. This requires the world of education to always adjust technological developments to improve the quality of education, especially in adjusting the use of science and technology in the science and technology learning process. This means that there is a need for renewal in the world of education so that students are able to adapt to technological developments in the digitalisation era. One of the appropriate methods is the development of electronic-based learning media.

Learning media refer to all tools or objects used in teaching and learning activities to convey learning messages from sources (such as teachers or other instructional resources) to learners, typically accessed via smartphones or laptops (Agustina et al., 2022). Messages conveyed through the media, in the form of content or teaching material, must be received by message recipients (students), using one or a combination of several of their sensory organs.

Comics are a form of reading in which students are expected to want to read without feeling forced / having to be persuaded (Sudjana & Rivai, 2013). This is certainly inseparable from the assumption that comic stories are easier to digest with the help of the images in them. The advantages of reading in the form of comics have been widely utilised by developed countries as a tool to increase children's interest in reading textbooks.

In addition, comics are images lined up in a deliberate sequence, intended to convey information or produce an aesthetic response from the reader McCloud (2001). This means that in making comics, it must go through the image making stage.

The language of images and text in comics is able to transfer understanding or information quickly to problems in the field using only writing. The messages conveyed through pictures and text in the form of narrative sequences capture students' attention and interest, ultimately enhancing learning outcomes.

The learning experiences students have received so far are often monotonous and lack variety, leading to boredom, and in the end, students do not understand the

messages conveyed during the learning process. This is a serious issue that requires attention. The solution to dealing with classroom learning problems is to create learning innovations with the help of appropriate technology. This is because learning methods in the 4.0 era require a change in learning strategies from conventional to online digital learning so that students become active in the classroom (Hasriadi, 2022; Sadiyah et al., 2021). The development of digital comic-based e-modules through the Canva application is one such innovation aimed at fostering students' creativity and active participation in creating an engaging and enjoyable classroom atmosphere. This research directly contributes to improving the learning process, as the developed comic media provides students with visual representations of the learning materials they read. Digital comics can serve as an effective tool to reduce student boredom when reading instructional texts in Indonesian, while also helping learners form a clearer mental picture of the content, thereby enhancing their comprehension of the subject matter.

METHODS

2.1 Place and Time of Research

This research was conducted at Noemuti State High School in August 2024. This study involved the development of digital comic-based e-modules using the Pixton application to improve students' creative thinking skills through Research and Development (R&D).

2.2 Tools

The tools used in this research were a laptop, LCD projector, and stationery.

2.3 Material

The materials used in this research included the developed e-modules, validation sheets, and student and teacher trial questionnaires.

2.4 Research Design

This research design refers to the *research and Development* (R&D) model of Thiagarajan, Semmel and Semmel consisting of four stages: (1) *define*, (2) plan (*design*) (3) *develop* and (4) *disseminate*. However, due to time considerations, this research was limited to the first three stages, namely: 1) defining, 2) planning, 3) developing.

The steps of the development procedure are as follows:

Stage 1. Preliminary Study

The aim is to gather input and identify the needs of the target object.

This stage involved a needs analysis technique applied to the biology teachers of Grade 10 SMA Negeri Noemuti. The preliminary study was conducted through interviews to obtain an overview and understand how the curriculum is implemented in the target school, the teaching materials used, and the learning tools available. It also included discussions on virus-related material to be used, assessment methods, time allocation, and learning resources.

Phase II. Model Development Phase

The procedure for developing the comic-based electronic modules followed the core competencies (KI) and basic competencies (KD) applicable to Grade 10 Science students at Noemuti State High School. At this stage, the researcher created the initial design of the electronic module, including a cover slide, learning objectives, virus-related material presented with digital comics, learning videos, and evaluation tests.

The stages of this development include:

1. Validation by material experts and media experts
2. Design Revision

Design revisions were carried out to correct errors or deficiencies identified during the development of the electronic comic-based modules, based on assessments from media experts, material experts, and Biology learning media feasibility experts.

3. Evaluation and Refinement

If the developed electronic module has shortcomings and has not yet reached the ideal design, revisions can be made to improve the product.

1. Trial Design

The development product trial was conducted in two stages: a small group trial involving 10 students selected based on their cognitive levels, and a large group trial involving 30 students selected randomly. Furthermore, the comic-based learning e-module was simulated using the Pixton application, after which students were asked to respond to the developed product through the distributed assessment instruments. This was done to test the feasibility of the developed comic-based e-module.

1. Trial Subjects

The test subjects in this development research consisted of two groups of students: a small group of 10 students and a large group of 30 students from Grade 10 at Noemuti State High School (Academic Year 2024/2025).

2. Data Type

The data collected in this development research are in the form of qualitative and quantitative data, namely:

1) Qualitative data

Qualitative data consists of responses and suggestions from media experts, material experts, and research subjects regarding the developed products.

2) Quantitative data

Quantitative data consists of assessment scores of the developed products from validators, as well as product feasibility assessments from students and Biology subject teachers, which serve as indicators of the quality of the digital comic-based e-module products.

3. Data Collection Instrument

1) Assessment Technique

The assessment technique used in this study involved a non-test method in the form of a questionnaire with a *Likert* scale for validation experts, covering aspects such as material feasibility and learning media feasibility. This provides assessment and input for the development of comic-based e-modules.

2) Data Analysis Technique

Quantitative descriptive data analysis was conducted to analyze data obtained from media expert validation sheets, material expert validation sheets, teacher assessments, and learner assessments gathered from questionnaires completed by respondents. These data focused on the feasibility of comic-based e-modules developed using the Pixton application. The data analysis was carried out in the following steps:

1. Feasibility assessment data by material experts and media experts

Data from media experts, material experts, and teacher responses are used to measure opinions, attitudes, and perceptions of individuals toward a social phenomenon, commonly applied in research. The expert validation sheets and respondent questionnaires contain five (5) rating scales, as shown in Table 2.1 below:

Table 2.1 Likert Scale Implementation

Score	**Description**
5	Very good
4	Good
3	Fair
2	Poor
1	Very Poor

Source: Riduwan, 2015

After data from media experts and material experts are obtained, calculations are carried out using the following formula:

$P = \frac{f}{N}$ x 100% (source: Riduwan, 2015)

Description:

P : Percentage of questionnaire data

f : Number of scores obtained
N : Number of criteria scores
100: Constant.

The e-modules that have been tested can be classified into feasibility categories. The eligibility criteria are presented in Table 2.2 below:

Table 2.2 *Eligibility Criteria for Validators*

Interval	Category
81-100 %	Very Valid
61-80 %	Valid
41-60 %	Fairly Valid
21-40 %	Less Valid
0-20 %	Very Invalid

Source: (Maulita & Erlita, 2021)

2. Teacher and Student Response Assessment Data

Teacher response data and learner responses are collected using a *Likert* scale. E-modules that have been validated by experts are then used in limited trials to test the feasibility of the developed product. Analysis of the results of the feasibility test of the products that have been developed is done by giving the answer score with the statement criteria on the questionnaire sheet as follows.

SS = Very Suitable (Score 5)
S = Suitable (Score 4)
CS = Quite Suitable (Score 3)
TS = Not Suitable (Score 2)
STS = Very Unsuitable (Score 1)

Furthermore, calculations were performed using a modified formula from Riduwan and Sunarto (as cited in Maulita & Erlita, 2021), namely:

$$NP = \frac{R}{SM} \times 100\%$$

Description:
NP: Percentage value sought
R : Raw score obtained
SM: Ideal maximum score

Data from teacher responses and learner responses can be categorised based on the E-module eligibility criteria table, which aims to determine whether the E-module developed is suitable for use by teachers and students or not, the E-module eligibility category can be seen in table 2.3 below:

Table 2.3 Eligibility Criteria for Respondents

Interval	Category
80 - 100	Very Feasible
66 - 79	Feasible
56 - 65	Fairly Feasible
46 - 55	Less Feasible
0 - 45	Very Infeasible

Source: Arikunto, 2010

The developed e-module is considered feasible if the percentage obtained is between 56–65%, categorized as "Fairly Feasible" without requiring revision, indicating that the product can be used as teaching material.

RESULTS AND DISCUSSION

3.1 Research Results

This development research (R&D) was conducted on Grade X students of SMA Negeri Noemuti, North Central Timor District.

The product developed in this study is a digital comic-based e-module, based on the development model proposed by Thiagarajan and Semmel in 1974. This model is known as the 4-D model, which consists of four stages: *Define, Design, Develop, and Disseminate*. Alternatively, it can be adapted into the 4-P model, namely Defining, Designing, Developing, and *Disseminating*. However, in this study, the *dissemination* stage was not carried out due to time and cost constraints.

3.2 The results of research on the development of digital comic-based e-modules on virus material

1) Initial Design of e-module using pixton application

The content of the comic-based e-module was initially developed as teaching material, designed using the Canva application. The initial design of the comic-based e-module is as follows:

1. Initial Cover Design

This comic-based e-module cover contains the module title. Figure 3.1 below shows the initial design of the front cover of the digital comic-based e-module.

Figure 3.1 Initial design of the front cover of the comic-based E-module

2. Basic Theory Page Design

The theoretical basis page contains virus-related material, including an outline of scientific studies. It also includes images and videos related to the virus topic, aiming to introduce the learning content through the developed e-module. Figure 3.2 below illustrates the initial design of the theory base page of the comic-based e-module!

Fig 3.2 Initial design of the comic-based E-module theory base page

3. Phase I Testing Results

This first-stage testing involved a validation process conducted by one material expert validator from the Biology Education Study Program and one media expert validator from the Information and Communication Technology Study Program at the University of Timor.

1) Material Expert Validation

Validators assessed three aspects: presentation, content, and language. The results of the material expert validation for the digital comic-based biology e-module on virus material are presented in Table 3.1 below:

Table 3.1 Material Expert Validation Results

Aspect of assessment	Statement	Score
Media	Interesting digital comic-based biology E-module design	4
	The clarity of the writing in the E-module is easy for students to understand	4
	Appropriateness of examples and images included in the E-module.	4
	The suitability of the video in the E-module with the material.	4
	The material presented in the E-module is interesting and can increase motivation for users.	3
	The suitability of the arrangement of the material presented is very clear.	3
	The e-module presented can provide *feedback.*	3
	The suitability of the example with the material in the E-module	4
Material	The material presented is very clear and easy to understand.	4
	The suitability of the material in the E-module is systematic and sequential.	3
	The language presented is very clear and easy to understand.	4

	Learning objectives in the E-module are in accordance with the basic competencies (KD)	3
	The material presented is in accordance with the basic competencies and learning objectives.	4
	The suitability of the questions contained in the E-module is in accordance with the material studied.	3
Cover	Question sentences do not cause double meaning	4
	The bibliography used in the E-module is appropriate.	3
Total Score		**61**
Percentage % 76.25%		
Eligibility criteria Valid		

Source: Modified from Sara, 2016

Based on table 3.1, the first validation results from the material expert validator yielded a feasibility percentage of 76.25%, which falls under the "Valid" category. Since this value lies within the 61–80% range (valid category), it indicates that the digital comic-based e-module can be used as teaching material with minor revisions. These include: 1) Improving the cover by adding the researcher's identity, 2) Including an introduction that contains learning objectives, learning indicators, a preface, and a table of contents, 3) Adding practice questions related to virus material in the e-module.

2. Media Expert Validation

Validators assessed three aspects: display (media), language, and presentation (content). The results of media expert validation are presented in Table 3.2 below

Table 3.2 Media Expert Validation Results (Phase I)

Aspects of assessment	**Statement**	**Score**
	Lay out accuracy,	4
	Appropriateness of background choices in comic-based E-modules	3
	The use of colours in the comic-based E-module is appropriate and creative.	4
Display aspect (Media)	The suitability of the selection of fonts used is easy to read clearly	5
	The font size used is easy to read and clear	4
	The videos presented are interesting, can be seen and heard clearly.	5
	The navigation function (instruction button) on the E-module is easy to use.	3
	Attractive and creative cover design.	3
	Comic-based e-modules are easy to operate using mobile phones, PCs, computers and laptops.	5
Language Aspect	The sentence structure in this comic-based E-module is simple and easy to understand.	4
	The language used by in this E-module is communicative.	4
	Use foreign/scientific names and symbols consistently	4
	The appropriateness of the language used is in accordance with the characteristics of the learners.	3
Presentation aspect (Material)	The presentation of the material in the E-module is clear and easy to understand.	4
	The accuracy of the images used in this comic-based E-module is in accordance with the material studied.	3
	Video illustrations are in accordance with the material learnt.	4
	The material is presented systematically.	4
	The material presented is in accordance with the basic competencies and learning objectives.	5
	The presentation of pictures, videos, and material can add insight and can be studied anywhere, anytime without the help of a teacher.	4
Total Score		**75**
Percentage % 78.94%		
Eligibility Criteria Valid		

Source: Modified from Sara, 2016

Based on Table 3.2, the first validation results from the media expert validator yielded a feasibility percentage of 78.94%, which falls under the "Valid" category. Since this value lies within the 61–80% range (valid category), it indicates that the digital comic-based e-module can be used as teaching material with minor revisions. These include: 1) Enhancing the visual design with more creative color choices and variations, 2) Adding more detailed explanations for each topic tailored to individual slides, 3) Including additional images such as animated visuals, suitable for a digital-based comic, 4) Improving the integration of images and videos on each slide, 5) Adding appropriate topic titles suitable for high school students.

4. Product Revision (Stage I)

Based on the validation results from the first stage of testing, feedback—including revisions, criticisms, and suggestions—was collected from both material and media expert validators regarding the developed product. This feedback will be used to improve the product's quality and ensure its suitability as teaching material.

3. Phase II test results

After the product was revised and improved, the second stage of testing was conducted to re-evaluate the product based on the validation results from the first stage.

1) Material Expert

Material expert validation was conducted by assessing three aspects: content, media, and cover design. The results of the material expert validation for the digital comic-based e-module are presented in Table 3.3 below.

Table 3.3 Material Expert Validation Results (Stage II Testing)

Aspects Assessment	Statement	Score
	E-module design for *Eubacteria* practicum is interesting	5
	The clarity of the writing in the E-module is easy for students to understand	4
Media	Appropriateness of examples and images included in the E-module.	5
	The suitability of the video/demonstration in the E-module with the material.	5
	The material presented in the E-module is interesting and can increase motivation for users.	5
	The suitability of the arrangement of the material presented is very clear.	4
	The e-module presented can provide *feedback*.	4
	The suitability of the example with the material in the E-module	5
Material	The material presented is very clear and easy to understand.	5
	The suitability of the material in the E-module is systematic and sequential.	5
	The language presented is very clear and easy to understand.	5
	Learning objectives in the E-module are in accordance with the basic competencies (KD)	5
	The material presented is in accordance with the basic competencies and learning objectives.	5
	The suitability of the questions contained in the E-module is in accordance with the material studied.	4
Cover	Question sentences do not cause double meaning	5
	The bibliography used in the E-module is appropriate.	5
Total Score		**76**
Percentage%		**95.00%**
Eligibility Criteria		**Very Valid**

Source: Modified from Sara, 2016

Based on Table 3.3, the results of the second validation from the material expert yielded a feasibility percentage of 95.00%, which falls under the "Very Valid" category. Since the percentage lies within the 81–100% range, it indicates that the digital comic-based e-module can be used as teaching material without requiring further revisions.

2. Media Expert

Media expert validation assessed three aspects: display (media), language, and presentation (content). The results of media expert validation are presented in Table 3.4 below:

Table 3.4 Media Expert Validation Results (Phase II)

Assessment aspect	Statement	Score
Appearance aspect (Media)	Lay out accuracy,	5
	Appropriateness of background choices in the E-module	5
	The use of colours in the E-module is appropriate and creative.	5
	The suitability of the selection of fonts used is easy to read clearly	4
	The font size used is easy to read and clear	4
	The videos presented are interesting, can be seen and heard clearly.	5
	The navigation function (instruction button) on the E-module is easy to use.	5
	Attractive and creative cover design.	4
	E-modules are easy to operate using mobile phones, PCs, computers and laptops.	5
Language Aspect	The sentence structure in the E-module is simple and easy to understand.	4
	The language used in the E-module is communicative.	4
	Use foreign/scientific names and symbols consistently	4
	The appropriateness of the language used is in accordance with the characteristics of the learners.	5
Presentation aspect (Material)	The presentation of the material in the E-module is clear and easy to understand.	5
	The accuracy of the images used in the E-module is in accordance with the material studied.	4
	Video illustrations are in accordance with the material learnt.	4
	The material is presented systematically.	5
	The material presented is in accordance with the basic competencies and learning objectives.	5
	Presentation of pictures, videos, and materials can add insight and can be studied anywhere, anytime without the help of a teacher.	4
Total Score		**86**
Percentage%		**90.53%**
Eligibility Criteria		**Very Valid**

Based on Table 3.4, the second validation results from media experts yielded a feasibility percentage of 90.53%, which falls under the "Very Valid" category. Since this value lies within the 81–100% range, it indicates that the digital comic-based e-module is highly suitable for use as teaching material. The product is considered very feasible and does not require further revisions based on feedback from media expert validators.

4. Product Testing

After the digital comic-based biology e-module on virus material passed the validation stage and was declared feasible by both material and media expert validators, the researcher conducted trials involving Biology subject teachers and Grade X students at Noemuti State High School to evaluate the module's feasibility and practicality. The trials included assessments by two Biology subject teachers, a limited/individual trial with 10 students, and a small group trial with 30 students. The small group trial involved *random sampling* without specific student criteria, whereas the limited/individual trial

used *purposive sampling* based on students' cognitive levels.

1) Biology teacher assessment trial (Respondent 1)

The trials involved two Biology subject teachers who acted as facilitators and instructors at the school. They assessed the product's feasibility by evaluating two aspects: content and media. The results for Respondent 1 are presented in Table 3.5 below:

Table 3.5 Biology Subject Teacher Assessment Results (Respondent 1)

Assessment Aspect	Statement	Score R1
Material	The suitability of the material in the digital comic-based e-module in the basic competencies (KD)	5
	The suitability of the material presented in the digital comic-based e-module with the learning objectives to be achieved	5
	The material presented in this comic-based e-module is interesting and able to increase student learning motivation.	5
	The material presented in the comic-based e-module can increase students' insight and knowledge.	5
	The material presented in the comic-based e-module can improve students' understanding of virus material.	5
	The background design of the E-module is very attractive.	4
	The clarity of the writing on the comic-based e-module can be read and easily understood.	5
Media	Use of grammar and sentence construction is easy to understand	5
	The use of images and videos is appropriate.	5
	With comic-based e-modules, students can learn independently easily anywhere (*practical*) and anytime (*flexibility*).	5
Total Score		**49**
Percentage %		**98%**
Feasibility Criteria		**Very Feasible**

Source: Modified from Sara, 2016

Based on Table 3.5, the results of the assessment by Biology subject teacher (Respondent 1) showed a feasibility percentage of 98.00%, which falls under the "Very Feasible" category. Since the score lies within the 80–100% range, it indicates that the digital comic-based biology e-module is highly suitable for use as teaching material without requiring any revisions.

2) Biology teacher assessment trial (Respondent 2)

The trials for Biology subject teacher (Respondent 2), who also served as a facilitator and instructor at the school, were conducted to assess the product by evaluating two aspects: content and media. The results for Respondent 2 are presented in Table 3.6 below:

Table 3.6 Biology Subject Teacher Assessment Results (Respondent 2)

Assessment Aspect	Statement	Score R2
Material	The suitability of the material in the digital comic-based e-module in the basic competencies (KD)	4
	The suitability of the material presented in the digital comic-based e-module with the learning objectives to be achieved	4
	The material presented in this comic-based e-module is interesting and able to increase student learning motivation.	5
	The material presented in the comic-based e-module can increase students' insight and knowledge.	5
	The material presented in the comic-based e-module can improve students' understanding of virus material.	5
	The background design of the E-module is very attractive.	5
	The clarity of the writing on the comic-based e-module can be read and easily understood.	5
Media	Use of grammar and sentence construction is easy to understand	5
	The use of images and videos is appropriate.	5

	With comic-based e-modules, students can learn independently easily anywhere (*practical*) and anytime (*flexibility*).	5
Total Score 48		
Percentage % 96.00%		
Feasibility	**Criteria**	**Very Feasible**

Source: Modified from Sara, 2016

Based on Table 3.6, the assessment results from the biology subject teacher (Respondent 2) yielded a score of 96.00%, which falls under the "very feasible" category for use as teaching material. This is because the feasibility criteria range from 80–100%, indicating that the digital comic-based biology e-module can be used without any revisions.

3) Limited or individual trial

An individual trial of the digital comic-based biology e-module for Grade 10 students at SMA Negeri Noemuti was conducted by distributing questionnaires to 10 students. The sample was selected using purposive sampling based on the respondents' cognitive levels. The results of this limited or individual trial are presented in Table 3.7 below.

Table 3.7 Results of Limited or Individual Trials

No.	Student response	Total score
1.	Respondent 1	47
2.	Respondent 2	44
3.	Respondent 3	40
4.	Respondent 4	43
5.	Respondent 5	44
6.	Respondent 6	44
7.	Respondent 7	42
8.	Respondent 8	41
9.	Respondent 9	41
10.	Respondent 10	40
Total score 426		
Percentage 85.20%		
Feasibility Criteria Very Feasible		

Based on Table 3.7, the limited or individual trial resulted in an average percentage of 85.20%, which falls into the "very feasible" category. According to the feasibility criteria (80–100%), this indicates that the digital comic-based biology e-module is highly valid and suitable for use as teaching material.

4) Small group trial

A small group trial was conducted among students to evaluate the developed digital comic-based biology e-module. A total of 30 Grade 10 students from SMA Negeri Noemuti participated in this trial. The participants were selected randomly, without specific selection criteria. The results of the small group trial are shown in Table 3.8:

Table 3.8 Small Group Trial Results

No.	Student response	Total score
1.	Respondent 1	44
2.	Respondent 2	42
3.	Respondent 3	41
4.	Respondent 4	41
5.	Respondent 5	40
6.	Respondent 6	42
7.	Respondent 7	47
8.	Respondent 8	46
9.	Respondent 9	44
10.	Respondent 10	45
11.	Respondent 11	45
12.	Respondent 12	44
13.	Respondent 13	44
14.	Respondent 14	46
15.	Respondent 15	45
16.	Respondent 16	45
17.	Respondent 17	47
18.	Respondent 18	40
19.	Respondent 19	46
20.	Respondent 20	40
21.	Respondent 21	46
22.	Respondent 22	48
23.	Respondent 23	45
24.	Respondent 24	45
25.	Respondent 25	45
26.	Respondent 26	44
27.	Respondent 27	42
28.	Respondent 28	45
29.	Respondent 29	42
30.	30 respondents	44
Total score 1320		
Percentage % 88%		
Feasibility Criteria Very feasible		

Based on Table 3.8 above, the results of the small group trial, in which samples were selected randomly without specific criteria, involved a total of 30 student respondents. The results show that the digital comic-based biology e-module falls into the "very valid" or "very feasible" category, with a percentage of 88%. Since this percentage lies within the feasibility range of 80–100%, it indicates that the digital comic-based biology e-module is highly suitable for use as teaching material.

5. Product Refinement

After the digital comic-based biology e-module was tested and declared feasible for use as teaching material, improvements were made to both its appearance and content. The final version of the e-module can be accessed *online* or *offline* via the links provided, as shown in Figure 3.3 below.

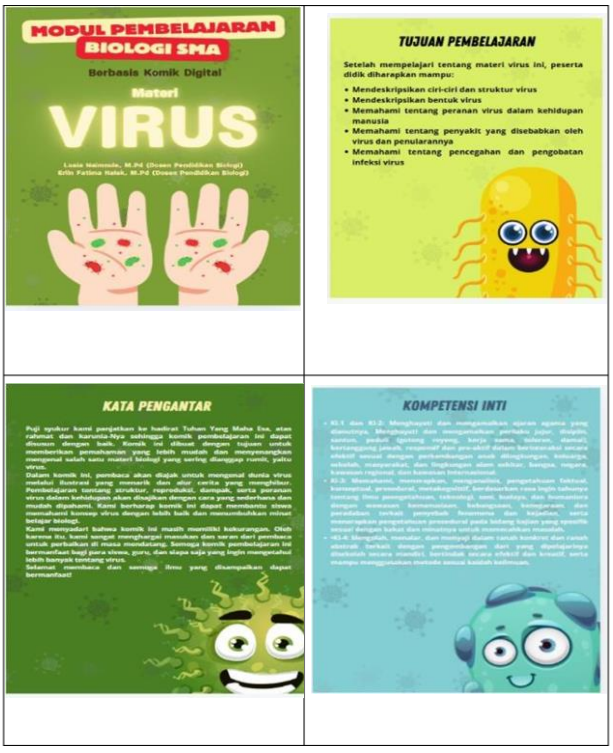

Figure 3.3. Design of digital comic enhancement of virus material

3.3 Discussion

The development of digital comic-based biology e-modules using the Canva application for Grade X students at SMA Negeri Noemuti was conducted through the *Research and Development (R&D*) method. Prior to product development, preliminary observations were carried out at the target school to identify problems and difficulties experienced during previous learning processes. These initial observations were conducted through interviews with Biology subject teachers and Grade X students. Following the preliminary study, researchers

designed an initial format for the e-module, including the cover, preface, table of contents, basic competencies (KD), virus material content, and accompanying questions. After the development product has been designed, the researcher conducts a testing or assessment process by material expert validators and media expert validators to determine the level of product feasibility, so that feasible products can be tested at the next stage.

Product validation involved two expert validators: one specializing in content (material validator) and the other in media design (media validator). In the first stage of material validation, the product achieved a score of 76.25%, which fell under the "valid" category, indicating that the product could be tested but required revisions, namely 1) improving the cover by adding the identity of the researcher, 2) adding an introduction which includes learning objectives, learning indicators, preface and table of contents, 3) adding questions to support virus material in the e-module.Meanwhile, the first validation stage for media experts received a percentage of 78.94% with valid criteria or suitable for use as teaching materials with several revisions, namely 1) a more creative display with a choice of colours and colour variations, 2) Need additional discussion of each topic adjusted for each slide, 3) Need additional images, for example animated moving images because this is a digital-based comic, 4) The combination of images and videos on each slide needs to be improved, 5) Topic titles must be added for the high school level.

After implementing the necessary revisions, the second stage of validation was conducted with the aim of re-testing the feasibility of the product that had been revised and improved previously. The results showed significant improvement: the second-stage material validation scored 95.00%, falling into the “very valid” or “very feasible” category, while the second stage of testing for media experts received a percentage of 90.5% with very valid criteria or very feasible to be tested on Biology subject teachers and students of Noemuti State High School. The results of the feasibility of the validated product are in line with previous research which states that the validation process by material experts and media experts is carried out first to test the feasibility of the product developed before being tested on students (Octafianus *et al.*, 2022; Sari, 2021; Sinensia *et al*, 2022; Qamariah *et al*., 2023).

After the digital comic-based biology E-module product is validated and declared very valid or very feasible by material expert validators and media expert validators. Furthermore, researchers conducted a trial stage to Biology subject teachers and trials to students. Trials to Biology subject teachers researchers involved two Biology subject teachers as teachers and facilitators at Noemuti State High School with the aim of seeing a comparison of the level of product feasibility, while product student trials were conducted in two phases: 1) Limited or individual trial involving 10 students; 2) Small group trial involving 30 students. The results from the teacher trial were highly positive: Respondent 1 gave a score of 98.00%; Respondent 2 gave a score of 96.00% with the suggestion that the e-module developed was very feasible to use as teaching material. The results of the limited or individual trial received a percentage of 85.20% and were declared very valid or very suitable for use as teaching materials. As for the results of the small group trial, it got a percentage of 88% and was declared very feasible to use as teaching material in learning activities.

E-modules are self-contained, systematically arranged instructional materials presented in electronic form, enriched with multimedia elements such as video, animation, and audio (Najihah *et al*., 2019). E-modules are modules in digital form, consisting of text, images, or both that contain digital electronics material accompanied by simulations that can and should be used in learning (Fauziah *et al.,*

2016; Herawati and Muhtadi, 2018; Imansari and Sunaryantiningsih, 2017). According to Elvarita *et al*., (2020) the advantages of E-modules are that the display design presented is made as attractive as possible so that it attracts students' interest and enthusiasm in studying the module. This is also supported by one of the studies conducted by Sidiq and Najuah (2020) which states that interactive E-modules can build, trigger, strengthen students' interest in learning independently and the learning process is more effective, efficient so that there is an increase in the quality of learning and improve the quality of education.

Effective educational comics should feature: a concise and logical storyline, realistic characterizations, colorful illustrations, clear and simple language. Comics have a function as a learning resource that has elements that support it so that it is feasible as a learning resource. As explained by Sudjana & Rivai (2013) that comics contain knowledge materials that are used as learning resources. The material contained in the developed learning comics is intended to increase students' interest in learning about virus material. This is because the comics developed through e-modules contain images that attract students' attention to read. Comics that are used as learning resources should contain a concise storyline with realistic characterizations, and be equipped with colour illustrations. This aims to foster interest in reading, increase vocabulary, and improve students' reading skills so that these comics become an effective learning resource. Waluyanto (2005) states that comics are a form of visual communication media that has the power to convey information and is easily understood by readers. Sudjana (2013) defines comics as a form of cartoon that reveals characters as stories in explanations related to images and designed to provide entertainment to readers.

The development of digital comic-based E-modules is intended so that students can learn independently without the help of teachers or other people to overcome problems such as time constraints, limited tools and materials, limited space. In addition, the digital comic-based E-module contains explanatory videos, interesting pictures, and simple explanations about the virus material studied by students. The e-module is accessible via a web link and can be shared across Android devices, laptops, tablets, PCs, or computers *online*. It is also available *offline* on similar devices using laptops, tablets, PCs, computers. For this reason, with the existence of digital comic-based E-modules, learning is more interactive and more interesting because it utilises technology and users can access and use it anywhere, anytime, and with anyone.

CONCLUSIONS

Based on the results of research on the development of digital comic-based biology e-modules for Grade 10 students at SMA Negeri Noemuti, the following conclusions can be drawn:

1. The development process of the digital comic-based biology e-module consists of two main stages: 1) Preliminary Study 2) Model Development Stage, which includes the following sub-stages: a) Product Design, b) Validation by material and media expert validators, c) Product revision based on validator feedback, d) Trials involving two Biology subject teachers and student groups.
2. The developed e-module was validated as very valid by both material and media experts. Trial results showed high feasibility. Teacher assessments yielded scores of 98.00% (Respondent 1) and 96.00% (Respondent 2), both categorized as “very feasible”. Student trials included: A limited trial result of 85.20%, categorized as "very feasible". A small group trial result of 88%, also categorized as "very feasible". Thus, the findings indicate that the digital comic-based biology e-module developed using the Canva application is highly

suitable for use as teaching material in Biology learning for Grade 10 students at SMA Negeri Noemuti.

ACKNOWLEDGMENTS

The research team would like to express sincere gratitude to the following parties for their support and contributions to this research: University of Timor, particularly the LPPM (Research and Community Service Institute), for facilitating this research through an internal research grant, enabling its successful implementation and positive impact on the partner school. SMA Negeri Noemuti, for serving as the research partner and actively supporting the execution of this study.

AUTHOR'S CONTRIBUTION

LN; 1) Ensured the proper execution of all research activities, 2) Prepared the learning materials to be used in the research, 3) Managed the overall preparation and coordination of the research, 4) Wrote and compiled the research article for publication.

EFH; 1) Assisted in preparing the instructional content for the e-module, 2) Developed the online and offline versions of the e-module and prepared data collection instruments, 3) Supported the writing and submission of the research article to Sinta 4 accredited journals.

FO; 1) Coordinated with the University of Timor's research institute regarding administrative matters**, 2)** Liaised with SMA Negeri Noemuti to schedule and manage research-related activities, 3) Supervised and facilitated the smooth implementation of the research.

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