Development Of Biotechnology Teaching Materials: E-Comics Complemented by Factual Videos to Improve Science Literacy Skills

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Abstract: Biotechnology might be difficult to understand. Comics were learning media that presented the material in the form of illustrated stories to make it more interesting, fun, not boring, and easily understood by students. Innovation makes comics in digital form, namely e-comics equipped with factual videos. The purpose of this study was to determine the feasibility of biotechnology e-comics equipped with factual videos, as well as the readability and response of students to biotechnology e-comics media equipped with factual videos. This research uses the ADDIE development model starting from the analysis, design, development, implementation, and evaluation stages. The samples used in this study were randomly selected XII-grade students of Sultan Daulat 1 Senior High School. Based on the research that has been done, the results obtained are: 1) Biotechnology e-comic media complemented by factual videos obtained a material validation score of 84% and media validation obtained a score of 93% with a very valid category. 2) Comic media obtained a readability score of 81.4% with a very good category 3) Students' responses to comic media obtained a score of 82% in the very good category. Based on these results, the biotechnology e-comic media equipped with factual videos is categorized as very valid, so it is feasible to use it as a learning media.

Keywords: Biotechnology; E-comics; Factual video; Science literacy; ADDIE.

Introduction

Science and technology mastery is a crucial key to national success in the 21st century, with biology education playing a critical role in developing globally competitive students (Wu et al, 2023). Biology learning serves as an access point for students to contextually recognize science and apply it in everyday life (Jamil et al, 2021). Students are expected to develop critical thinking skills, logical reasoning, and the ability to solve problems and make wise decisions based on scientific facts (Jamil et al, 2021).

Scientific literacy, defined by the OECD as the skill to use scientific knowledge to describe natural phenomena and solve problems through scientific methods, remains a challenge for Indonesian students (Faidah & Maarif, 2022). PISA survey results reveal that Indonesia ranks 70th out of 78 countries, with a science literacy score of 396, significantly below the international average of 489 (Fortus et al, 2022). The low achievement is directly linked to learning processes that have not provided opportunities for students to enhance critical thinking skills (Suna et al, 2020).

The novelty of this research lies in its innovative approach to addressing the low science literacy problem by developing an e-comic with integrated factual videos specifically designed for biotechnology learning at Sultan Daulat 1 Senior High School in Southeast Aceh Regency. This unique research aims to create cutting-edge learning media that combines visual storytelling through interactive comics and real-world scientific video content. By addressing the limitations of traditional teaching methods, the study seeks to provide a novel solution that can potentially transform science

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literacy skills among students by making complex biotechnology concepts more engaging and accessible.

The COVID-19 pandemic has accelerated the adoption of digital learning tools (Almeida et al, 2023; Berger et al, 2023)), with interactive comic media emerging as an innovative and attractive learning approach. Comics serve as a visual medium that can convey messages through interesting storylines, helping to increase student imagination and provide engaging learning experiences (Syakur, 2020; Pereira et al, 2023). The research recognizes the importance of learning media in motivating students and aims to develop a tool that can effectively bridge the gap in science literacy education, particularly in the field of biotechnology.

Method

An overview of the research methods and design in this research can be seen in Figure 1. This type of research is the R & D ADDIE research model, which is a development model with a design consisting of the analysis stage (analyze), design stage (design), development stage (develop), implementation stage (implementation), and the final stage, namely assessment (evaluate) (Yulia et al, 2023). The large-scale field trial used a type of Quasi Experiment research with a design (One group pre-test and post-test design) (Shahat et al, 2024).

Research Time and Location; Research time is from March 2024 to September 2024. The research location is the Master of Biology Education Study Program, State University of Medan and Sultan Daulat 1 Senior High School, Sultan Daulat Regency Southeast Aceh. The population and sample of this study are as follows: The population in this study were Biology Teachers and students of Sultan Daulat 1 Senior High School Regency Sultan Daulat Southeast Aceh, while the sample in this study were biology teachers and students of Sultan Daulat 1 Senior High School, Regency Sultan Daulat Southeast Aceh met the research inclusion criteria, namely: Teachers and students who are willing to be research respondents.

Primary data collection is done by (1) Observation, making observations to get an idea of what kind of product is made, (2) Interviews, to get deeper information about what is a problem in the world of education, (3) Black-box testing is used to test the functional input and output of E-comics equipped with factual videos, (4) Questionnaires, instruments used in collecting data on respondents' opinions using pre and post-test questions to determine the effectiveness of biotechnology E-comic products equipped with factual videos, (5) Validation, instruments used to collect data from media and material experts (Dengel et al, 2023).

Secondary Data is obtained from data taken from the curriculum section of Sultan Daulat 1 Senior High School.

Data processing aims to produce correct information for research objectives. The steps are:

a. Editing was an activity to check the contents of the questionnaire form.

b. Coding is defined as the activity of converting data in the form of letters into data in the form of numbers or numbers.

c. Processing which processes data so that it can be analyzed. Data processing is done by entering data from the questionnaire into a computer program package.

d. Cleaning data (data cleaning) is an activity of checking the data that has been entered and whether there are errors or not (Khoa et al, 2023).

Data analysis of the feasibility of biotechnology E-comics equipped with factual videos was carried out with the technique of analyzing the feasibility of biotechnology E-comics equipped with factual videos. Data analysis of the effectiveness of biotechnology E-comics equipped with factual videos is carried out with data analysis techniques to find out the effectiveness of using biotechnology E-comics equipped with factual videos on biotechnology knowledge using Wilcoxon analysis.

Data analysis of the effectiveness of biotechnology E-comics equipped with factual videos in improving science literacy skills, analysis of the results of teacher needs interviews with Biology subject teachers, analysis of the results of questionnaires on the needs of students who take part in biotechnology learning (Andarukmi et al, 2024).
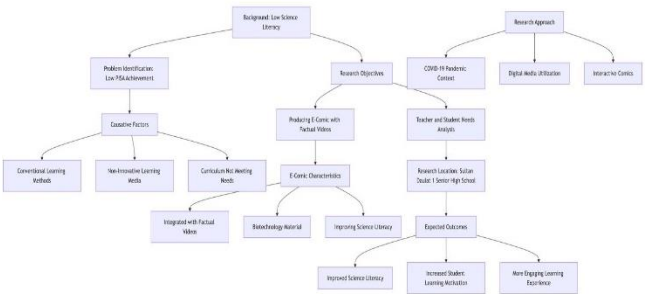

Figure 1. Overview of Research Design and Method

Result and Discussion

Based on the needs analysis through interviews with biology teachers and filling out questionnaires by XII grade students at Sultan Daulat 1 Senior High School, the following results were obtained.

Table 1. Teacher Interview Results

Question	Answer
How did you motivate students to be active in learning activities in class?	I always say that all students can have an opinion, and don't need to worry if the answer is wrong because the most important thing is the courage to express opinions. Give positive appreciation to active students. Communicate with passive students with questions that adapt to the student's character/ability.
What kind of teaching materials did you use during learning activities in class?	(Student Worksheets, package books, Learner Worksheets, modules, e-modules, etc.) Package books, practical tools, and materials
What learning resources are used in learning Biology? (Printed edition, environment, internet, etc.)	Printed (books, student worksheets), internet, parents/community members who have expertise according to the material taught.
How often do you use the internet in biology learning activities?	Almost every learning material uses the internet to dig up information or confirm the results of the discussion.
How does the use of the internet affect the learning of biology that you apply?	Assist students in understanding the material by digging deeper into information from the textbook.
What learning media do you use in Biology learning activities? (LCD, diorama, KIT, video, pictures, gadgets, PPT, comics)	LCD, pictures, KIT, videos, mock models, computer applications (Canva, PHET)
Among these learning media, which learning media are often used in learning activities?	Video, LCD, pictures
What do you think about the science literacy competencies that are important for students to master in the 21st century?	Science literacy competencies need to be mastered by students.
Based on the teaching materials, learning resources, and learning media that have been used, how is the development of students' science literacy at Sultan Daulat 1 Senior High School?	Less than optimal, students still need a lot of guidance.
Do you often practice science literacy with students when learning Biology?	Almost every learning meeting.
If yes, how is the current science literacy of students at Sultan Daulat 1 Senior High School?	Less developed because students' learning motivation is still lacking. They only learn when at school so critical thinking skills still need to be raised and developed.
What curriculum is currently used at Sultan Daulat 1 Senior High School? (Class X, XI, XII)	Class X (Merdeka Curriculum) Class XI and XII (2013 revised curriculum)
With the independent curriculum, does it have an impact on the learning media used?	Yes
Is the learning media following the independent curriculum able to meet the needs of students at Sultan Daulat 1 Senior High School?	No
What were your obstacles in preparing learning media following the independent curriculum?	I cannot provide media for differentiated learning.
Have you ever used interactive comic media in the 2023/2024 school year?	Not yet
According to you, what kind of interactive comic media is good to use in learning Biology?	Those that attract students to read, take issues that students like, and provide a deeper understanding for students than reading ordinary textbooks.
How do you respond to interactive comic media which includes factual videos?	Very interesting and interactive
Are there any obstacles in biotechnology material that hinder learning activities?	Available
How many meetings are needed on biotechnology material?	4
How do you convey biotechnology material to students?	Through literacy activities, using videos to help students understand the biotechnology, and utilizing Canva for student assignments.

Table 2. Students Interview Results

Statement	Percentage (%)			
	Totally Agree	Agree	Disagree	Totally Disagree
Biology subject is difficult to understand	-	70	26.7	3.3
Biotechnology material is difficult to understand.	6.7	53.3	30	10
I have difficulty understanding biotechnology through the learning media used by the teacher	3.3	76.7	13.3	6.7
I need to learn media that is interactive learning media	-	76.7	23.3	-
I prefer to use learning media in the form of learning media in the form of comics	6.7	50	30	13.3
I find it easier to understand the material. biotechnology material if presented in the form of pictures	33.3	60	3.3	3.3
I find it easier to understand biotechnology material if it is presented in the form of a storyline	20	53.3	23.3	3.3
I prefer to solve problems based on scientific evidence	10	53.3	36.7	-
I have described phenomena scientifically	-	36.7	60	3.3
I am used to describing phenomena scientifically	-	33.3	66.7	-
I find it difficult to identify scientific problems	-	60	40	-
I try to describe or interpret phenomena scientifically and predict changes.	-	70	26.7	3.3
I can interpret scientific evidence and make and communicate conclusions.	6.7	30	56.7	6.7

Question

How do teachers deliver lessons in class?
Answer: (can be more than one)
☐ Lecture (46.7%)
☐ Writing on the whiteboard (63.3%)
☐ Dictating (16.7%)
☐ Using learning media (36.7%)
☐ Others: (6.6%)
What difficulties are experienced in understanding the material?
Answer: (may be more than one)
☐ Teachers only give explanations (43.3%)
☐ Less interesting learning media (23.3%)
☐ Boring learning activities (43.3%)
☐ Lack of learning facilities (10%)
☐ Others: (3.3%)
What are your favorite biology learning activities in class?
Answer: (more than one)
☐ Assignment (33.3%)
☐ Group discussion (46.7%)
☐ Discussion of controversial issues (16.7%)
☐ Problem-solving (30%)
☐ Presentation (3.3%)
☐ Practicum (13.3%)
☐ Others: (3.3%)
What learning media are often used by teachers?
Answer: (can be more than one)
☐ LCD (3.3%)
☐ Diorama (16.7%)
☐ KIT (3.3%)
☐ Video (6.7%)
☐ Pictures (63.3%)
☐ Gadgets (0%)
☐ PPT (6.7%)
☐ Comics (0%)
☐ Others: (3.3%)
What learning media do you prefer?
Answer: (can be more than one)
☐ LCD (10%)
☐ Diorama (10%)

☐ KIT (3.3%)
☐ Video (26.7%)
☐ Pictures (70%)
☐ Gadgets (13.3%)
☐ PPT (6.7%)
☐ Comics (20%)
☐ Others: (3.3%)

What kind of learning media can increase your motivation to learn? (May be more than one)
Answer: Interactive, Silent Visual Media, Comic, Picture Media.
How do you respond to the use of interactive comic media equipped with factual videos in learning Biology?
Answer: Interesting Agree, the use of interactive comics should not only be used in Biology but also in other subjects that allow Interactive comic media is valid and practical to use in learning biology.

Based on the results of the needs analysis with interviews with Biology teachers and students of class XII Sultan Daulat 1 Senior High School, it was found that the results of interviews with teachers related to science literacy that is important for students to master in the 21st century including competencies that need to be mastered by students. The use of teaching materials, learning resources, and learning media by teachers for the development of students' scientific literacy is still not optimal and students still need a lot of guidance. The current condition of students' science literacy is less developed because students' learning motivation is still lacking. They only learn when at school so critical thinking skills still need to be raised and developed.

This is following the results of the student needs analysis questionnaire based on several indicators of science literacy, which show that as many as 60% of students disagree if they have described phenomena scientifically, as many as 66.7% of students disagree if they are accustomed to describing phenomena scientifically, as many as 60% of students agree if they find it difficult to identify scientific problems, and as many as 56.7% of students disagree if they can interpret scientific evidence and make and communicate conclusions. The science learning process that does not provide opportunities for students to improve their critical thinking skills causes low science learning outcomes for students (Adhelacahya et al, 2023). Science literacy combine science and science knowledge and several skills, including investigation, critical thinking, problem-solving, and decision-making (Osborne, 2023).

The way teachers deliver learning in the classroom is through lectures (46.7%) and writing on the blackboard (63.3%). Students also find it difficult to understand the material due to several factors, including the teacher only gives explanations (43.3%), the learning media is less interesting (23.3%), and learning activities are boring (43.3%). In line with this statement, learning with students as passive listeners and only teacher-centered will cause boredom in students. This will make students not have thoughts and knowledge about science literacy. Therefore, teachers must build a learning atmosphere that involves student activeness to improve science literacy in biology learning. Learning media to support teachers and motivate students can never be separated from the learning process (Balla, 2023). The curriculum and education system, the selection of learning methods and models by teachers, learning media or tools, and teaching materials that do not meet 21st-century learning objectives are some of the factors that cause low student science literacy. One factor that is directly related to learning activities and affects students' low science literacy is learning media.

The existence of an independent curriculum has an impact on the learning media used (Aini, 2023). Teachers have obstacles in preparing learning media by the independent curriculum, namely not being able to provide media for differentiated learning. In the learning process, there are also no interactive comics used by teachers as learning media. Good interactive comic media used in learning biology is that which attracts students to read, takes issues that students like and provides deeper understanding for students than reading ordinary textbooks. Interactive comic media which presents a hollow conversation becomes very interesting and interactive. In addition, in biotechnology material, some obstacles hinder learning activities.

This is following the results of the student needs analysis questionnaire showing that as many as 76.7% of students agree that they need interactive learning media, as many as 50% of students agree that they prefer to use learning media in the form of comics, as many as 60% of students find it easier to understand biotechnology material if it is presented in the form of images, and as many as 53.3% of students agree that it is easier to understand biotechnology material if it is presented in the form of a storyline. A non-moving image media is organized in the form of a storyline. Comics are a visual medium that functions as a popular means of conveying messages in the form of images and writing in the form of interesting and easy-to-understand storylines and can help increase imagination and provide student learning experiences so that they have an impact on improving learning outcomes. In line with this statement, the use of learning media in the form of comics can develop learning motivation, learning quality, and foster

students' interest in reading, and guide students to reading discipline (Cotiangco et al, 2024).

The results of the observation are in the analysis of learning objectives containing curriculum analysis where Class XII Sultan Daulat 1 Senior High School uses the 2013 Curriculum. In addition, the analysis was also carried out to determine the characteristics of students by conducting interviews with teachers and distributing questionnaires to students. The needs analysis was conducted by interviewing teachers and students, as well as distributing questionnaires to students. The results of the analysis of student characteristics stated that students like biology lessons, students also like learning with visual displays, and students like biology lessons based on the difficulty of the material. The results of the needs analysis obtained show that all students have never used biotechnology e-comics equipped with factual videos, students actively ask, answer, and argue when learning biology. Students also use learning media other than textbooks, such as projectors and other learning media brought by the teacher.

Analysis of media feasibility from experts shows that there are several revisions such as adding pictures to each material point and giving pages, the preface changes to the preface, giving reading sequence numbers in each column, and adding further information about biotechnology. The analysis of validation results by media experts can be seen in Table 3 and Figure 2.

Table 3. Recapitulation of media expert validation results

Learning Media			
No	Aspect	Average Validity Score	Description
1	Media Display	0.87	Perfectly Valid
2	Media content	0.83	Perfectly Valid
3	Language	0.91	Perfectly Valid
4	Practicality of Use	1	Perfectly Valid
	Average score	0.9	Perfectly Valid
Readability			
1	Instructions	0.87	Perfectly Valid
2	Clarity	0.75	Perfectly Valid
3	Language Accuracy	1	Perfectly Valid
	Average score	0.87	Perfectly Valid

The second aspect is the media content aspect. The media content aspect consists of 3 statements that get a validation score of 0.83 with a very valid category. This shows that the material presented in biotechnology e-comics equipped with factual videos is under learning and the media can be used in learning.

Figure 2. Results of Feasibility Test by Media Experts

The presentation of biotechnology e-comics equipped with factual videos will affect the information obtained by students. The third aspect is the language aspect. The language aspect consists of 3 indicators that get a validation score of 0.91 with a very valid category. The fourth aspect is the practicality of use aspect. This aspect consists of only one indicator that gets a validation score of 1 with a very valid category. This shows that biotechnology e-comics equipped with factual videos are practical and easy to use.

The media content aspect obtained the lowest score on media feasibility because the media content is less coherent and clear so biotechnology e-comics media equipped with factual videos tend to be a little complicated to understand each plot. The results of the overall analysis of the media aspects of biotechnology e-comics equipped with factual videos obtained a validation value of 0.9 with a very valid category. The highly valid category ranges from 75% < P ≤ 100%. P values greater than 75% were found in the overall analysis of science fiction media aspects. This shows that media experts agree that biotechnology e-comics equipped with factual videos are reliable and can be used for student learning. Analysis of validation results by material experts can be seen in Table 4 as follows.

Table 4. Recapitulation of media expert validation results

No	Aspect	Average Validity Score	Description
1	Learning	0.75	Perfectly Valid
2	Correctness of Content	0.75	Perfectly Valid
	Average score	0.75	Perfectly Valid
Readability			
1	Instructions	0.87	Perfectly Valid
2	Clarity	0.75	Perfectly Valid
3	Language Accuracy	1	Perfectly Valid
	Average score	0.87	Perfectly Valid

Based on Table 5, the material expert validation on the learning aspect and the aspect of the correctness of the material content obtained a validity value of 0.75, so the average validity score was also 0.75 with a very valid category. Based on the validation results, it show that the material presented in the biotechnology e-comic equipped with factual videos follows the curriculum, the material is clear, and the language and terms are also clear. Learning materials must be relevant to the material being studied. Students will be able to obtain information or knowledge well if the content is accurate and extensive. The second aspect is the correctness of the material content. Based on the validation results, it shows that in the biotechnology e-comic equipped with factual videos, there is real biotechnology material for high school. The language used is easy to understand and the material is clear. Both aspects are said to be very feasible and can be used in learning.

Material validators provided improvements, namely adding material points, providing pages, providing reading order numbers, and adding

information about genetic engineering. The results of the overall analysis of the material aspects of biotechnology e-comics equipped with factual videos obtained a validation value of 0.75 with a valid category. The highly valid category ranges from 75% < P ≤ 100%. The results of the overall analysis of the material aspects of biotechnology e-comics equipped with factual videos obtained a value of P> 75%. This shows that biotechnology e-comics equipped with factual videos are declared very valid by material experts and are suitable for use in learning for students. Furthermore, the results of validation by biotechnology lecturers can be seen in Table 5 as follows.

Table 5. Recapitulation of validation results by material expert lecturers

No	Aspect	Average Validity Score	Description
The material			
1	Content	0.87	Perfectly Valid
2	Language	1	Perfectly Valid
	Average score	0.93	Perfectly Valid
Media			
1	Visual	0.91	Perfectly Valid
2	Practicality	1	Perfectly Valid
3	Creativity	1	Perfectly Valid
	Average score	0.97	Perfectly Valid
Readability			
1	Instructions	1	Perfectly Valid
2	Clarity	1	Perfectly Valid
3	Language Accuracy	1	Perfectly Valid
	Average score	1	Perfectly Valid
Response			
1	Instructions	1	Perfectly Valid
2	Clarity	1	Perfectly Valid
3	Language Accuracy	1	Perfectly Valid
	Average score	1	Perfectly Valid

Validation of biotechnology e-comics media complemented by factual videos by biotechnology lecturers consists of 2 points, namely media and material. In terms of material, there are 2 aspects, namely material content, and language. In the content aspect, the material obtained a validation score of 0.87 with a very valid category and the language aspect obtained a validation score of 1 with a very valid category. The average validity score is 0.93 with a very valid category. In terms of media, there are 3 aspects, namely visual aspects, practicality, and creativity. The visual aspect obtained a validation score of 0.91 with a very valid category, the practicality aspect obtained a validation score of 1 with a very valid category, and the creativity aspect obtained a validation score of 1 with a very valid category.

The average validity score is 0.97 with a very valid category. Based on the validation results from the biotechnology lecturer, it shows that the biotechnology e-comic media accompanied by factual videos are valid from various aspects, namely the material is really presented, accurate, and coherent. The language used is also simple and communicative. The design of biotechnology e-comics equipped with factual videos is stated to be neat, images and text are combined, practical, creative, and innovative. Therefore, biotechnology e-comics equipped with factual videos can be used by students in learning. The overall aspects on readability and response by biology teachers were declared very valid with each average validity score of 1.

The readability and response questionnaires were distributed to three scales: individuals, small groups, and implementation groups or large groups. Students are directed to open the biotechnology e-comic equipped with factual videos provided, and then read it. Students study and understand biotechnology e-comics equipped with factual videos presented. After that, students were given a readability questionnaire and a response questionnaire to determine the readability and student response to the biotechnology e-comic equipped with factual videos integrated with environmental literacy on the topic of biotechnology. The following results of the individual readability questionnaire can be seen in Table 6.

Table 6. Recapitulation of individual readability questionnaire data

No	Indicator	Readability Score (%)	Description
1.	Media	87.5	Excellent
2.	Language	75	Excellent
3.	Material	75	Excellent
	Average score	79.02	Excellent

The first indicator in the individual trial is visual. The score of the media indicator is 87.5% with a very good category. The writing in biotechnology e-comics equipped with factual videos is clear, the images are clear, and the size and type of font are appropriate will make students like the use of biotechnology e-comics equipped with factual videos integrated with environmental literacy on the topic of biotechnology. Image media can increase students' enthusiasm for participating in the learning process. The second indicator in the individual trial is language. The score of the language indicator is 75% with a very good category.

The third indicator is interest. The score of the material indicator is 75% with a very good category. Biotechnology e-comics equipped with factual videos that are presented are interesting, have good colors, and the names of the characters are easy to remember it will

make students interested in using biotechnology e-comics equipped with factual videos. The total score of biotechnology e-comics equipped with factual videos in the individual test obtained an average score of 79.2% in a very good classification. The research shows that the excellent category is about 75%<P<100%. The consequence of the general investigation on the single initial comprehensibility survey got a value of P> 75%. Furthermore, the individual response questionnaire results can be seen in Table 7 as follows.

Table 7. Recapitulation of individual response questionnaire data

Indicator	Response Score (%)	Description
Material	75	Excellent
View	75	Excellent
Interest	83	Excellent
Average score	77.7	Excellent

The first indicator in the individual trial response questionnaire is the material. The score of the material indicator is 75% with a very good category. The biotechnology material is complete and easy to understand so that students can learn using biotechnology e-comics equipped with factual videos. The topic of genetic engineering is interesting to be discussed in biotechnology e-comics equipped with factual videos because the results exist in everyday life related to this material. Some genetic engineering and biotechnology products become necessary to be implemented into the form of knowledge, innovation, and education to build a comprehensive understanding.

The second indicator is display. The score of the display indicator is 75% with a very good category. The third indicator is interest. The score of the attraction indicator is 83% with a very good category. In biotechnology e-comics equipped with factual videos, there are interesting pictures and bright colors so that students feel happy and like the material in biotechnology e-comics equipped with factual videos so that they do not feel bored and focus on learning. The material and display aspects get the same score of 75%, this is because these indicators do not provide a very broad understanding and sufficient attractiveness for students on an individual scale.

The results of the overall analysis of the biotechnology e-comic response questionnaire equipped with factual videos in the individual test obtained an average score of 77.7% in the very good category. The excellent category ranges from 75% to 100%. The consequence of the general investigation on the single initial comprehensibility survey got a value of P> 75%. The results of the readability questionnaire on the small-scale trial can be seen in Table 8.

Table 8. Recapitulation of small-scale readability questionnaire data

Indicator	Readability Score (%)	Description
Media	88.75	Excellent
Language	100	Excellent
Material	95	Excellent
Average score	94.6	Excellent

The first indicator in the small-scale trial is the media. The score of the visual indicator is 88.75% with a very good category. The writing in biotechnology e-comics equipped with factual videos is clear, the images are clear, the size and type of font are appropriate will make students like the use of biotechnology e-comics media equipped with factual videos. The use of good media in learning will create a desire to learn and be eager to understand the material. The second indicator in the small-scale trial is language. The score of the language indicator is 100% with a very good category. The language in biotechnology e-comics equipped with factual videos is clear and easy to understand, which will make students have no difficulty reading or understanding the material in biotechnology e-comics that are complemented by factual videos.

The use of simple language will be easy to understand and will not cause difficulties for students in the learning process. The third indicator is interest. The score of the material indicator is 95% with a very good category. The media aspect in the small-scale trial obtained the lowest score because the media presented in print could not be enlarged in certain parts that wanted to be seen more clearly. The results of the overall analysis on the questionnaire of the readability of biotechnology e-comics equipped with factual videos in the limited scale test received an average score of 94.6% in the excellent classification. The excellent category is about 75% P 100%. The consequence of the general investigation on the single initial comprehensibility survey got a value of P > 75%. This shows that biotechnology e-comic complemented by factual videos is feasible to be implemented on a large-scale trial. The results of the response questionnaire on the small-scale trial can be seen in Table 9 as follows.

Table 9: Recapitulation of small-scale response questionnaire data

Indicator	Response Score (%)	Description
Material	98	Excellent
View	93	Excellent
Interest	86	Excellent
Average score	92	Excellent

This aspect obtained the lowest score compared to other aspects because students on a small scale were less satisfied with the media provided in print due to limited conditions, so they felt less interested. The results of student responses to biotechnology e-comics equipped with factual videos on small-scale trials received an average score of 92% in the very valid category. The excellent category ranges from 75% to 100%. The consequence of the general investigation on the single initial comprehensibility survey got a P value > 75%. This shows that biotechnology e-comics equipped with factual videos are feasible to be implemented in large-scale trials. The results of the readability questionnaire on a large scale can be seen in Table 10.

Table 10: Recapitulation of large-scale readability questionnaire data

Indicator	Readability Score (%)	Description
Media	81.25	Excellent
Language	82.8	Excellent
Material	80.7	Excellent
Average score	81.4	Excellent

The first indicator in the large-scale trial is the media. The score of the media indicator is 81.25% with a very good category. Images are more realistic than verbal so it is interesting for students to learn. The second indicator in the large-scale trial is language. The score of the language indicator is 82.8% with a very good category. Clear language will make it easier for students to understand the material. This is related to cognitive learning theory where a person's behavior is determined by his learning process in understanding something. Language is a means of delivery that includes discourse, sentences, paragraphs, and vocabulary. The use of language with a clear sentence structure will make it easier for students to understand the material being taught.

The third indicator is the material. The score of the material indicator is 80.7% with a very good category. With the comics, students find it easier to learn the material because the comics are arranged according to the learning objectives so that they are easy to understand. The material aspect obtained the lowest score because the material coverage was considered incomplete and did not understand the meaning of the material sequence. In the large-scale test, the overall analysis of the readability questionnaire of biotechnology e-comics equipped with factual videos resulted in an average score of 81.4%, placing it in the excellent category. A P value greater than 75% was found in the overall analysis of the readability questionnaire for the large-scale trial. This shows that biotechnology e-comics equipped with factual videos are suitable for use in learning. Furthermore, the results

of the response questionnaire on the large-scale trial can be seen in table 11.

Table 11. Recapitulation of large-scale response questionnaire data

Indicator	Response Score (%)	Description
Material	83.85	Excellent
View	79	Excellent
Interest	83.85	Excellent
Average score	82	Excellent

The material is the first indicator in the response questionnaire for the large-scale trial. The material indicator scored 83.85% with a very good category. Between small-scale and large-scale trials, the results on the material indicator are different. This is because on a small scale, reading and understanding biotechnology e-comics equipped with factual videos takes less time, while on a large scale, reading and understanding biotechnology e-comics equipped with factual videos takes longer. As a result, the student response questionnaire score in the large-scale trial was higher. The biotechnology material presented in the biotechnology e-comic equipped with factual videos is processed and then understood by students. This is following Gagne's learning theory where a person explores, processes, and then stores the information that has been obtained.

The second indicator is display. The score of the display indicator is 79% with a very good category. The images presented in the biotechnology e-comic equipped with factual videos will help students associate the material presented with events in everyday life, this is in accordance with David Ausubel's meaningful theory where a person associates existing information with facts or experiences. Comic media can present a concrete picture of the story with an attractive image design and conversation.

The third indicator is interest. The score of the attraction indicator is 83.85% with a very good category. There are differences in results on small and large-scale trials due to time, accuracy, and student understanding when filling out the questionnaire, but not too significant so the results are equally good. The media will be said to be interesting if it can attract students' attention and students can understand the material well when using the media.

The display aspect received the lowest score because the printed display was less favorable to students due to limited access to features as in digital media. The average score of 82% places the science fiction response questionnaire on the large-scale test in the excellent category, according to the overall analysis. A P value greater than 75% was found in the overall

analysis of the readability questionnaire for the large-scale trial. This shows that biotechnology e-comics equipped with factual videos are suitable for use in learning.

In this development study, the evaluation stage was carried out formatively, or at each stage of the ADDIE development model. Validators, readability questionnaires, and response questionnaires are the basis for evaluation and then adjusted to the usefulness of biotechnology e-comics equipped with factual videos. There were no suggestions given by media experts. On the feasibility of the material given advice, namely 1) Add pictures to each material point and give pages, 2) The foreword is changed to preface, 3) Add more information for reforestation. The biology teacher gave advice, namely give a reading sequence number in the image column. In the readability and response questionnaire, there were no suggestions from students for small-scale and large-scale subjects. Based on these results, it shows that the topic of biotechnology is a concept related to genetic engineering. In biotechnology e-comics equipped with factual videos, and images ranging from traditional biotechnology to modern biotechnology are presented in biotechnology e-comics equipped with factual videos. Based on the results obtained, it can be concluded that biotechnology e-comics equipped with factual videos can be used and understood by students learning Biology.

Conclusion

Based on the results of the needs analysis of teachers and students related to interactive comics to improve science literacy conducted at Sultan Daulat 1 Senior High School using data collection techniques in the form of interviews and questionnaires. The targets of this study were biology teachers and students of class XII Sultan Daulat 1 Senior High School. The needs analysis was conducted on 1 (one) biology teacher and 30 (thirty) students of class XII. The targets of this research are 1) the condition of students' science literacy, 2) the needs of teachers and students related to interactive comics as learning media on biotechnology material, and 3) students' difficulties in understanding biotechnology material. The results of the needs analysis obtained showed that 1) Students' science literacy at Sultan Daulat 1 Senior High School is less developed because students' learning motivation is still lacking. They only learn when at school so critical thinking skills still need to be raised and developed, 2) learning media is needed to improve students' science literacy in biotechnology material, 3) interactive comic media is very interesting so it needs to be developed on biotechnology in the form of interactive comics that not

only present images and writing but also provide hollow conversations.

The development of biotechnology e-comics equipped with factual videos integrated with science literacy on the topic of biotechnology based on the results of school research was declared feasible based on the results of media expert analysis resulting in an average value of 0.9 with a very valid category, material expert analysis resulted in an average value of 0.75 with a very valid category, and the results of the analysis of biotechnology lecturers resulted in an average value of 0.93 in material aspects and 0.97 in media aspects with very valid categories for both. The results of the readability questionnaire on the individual trial resulted in an average value of 79.2% with a very good category, the readability questionnaire on the small-scale trial obtained an average value of 94.6% with a very good category, on the large-scale trial resulted in an average value of 81.4% with a very good category. The results of the response questionnaire on the individual trial produced an average value of 77.7% with a very good category, the response questionnaire on the small-scale trial obtained an average value of 92% with a very good category, and on the large-scale trial produced an average value of 82% with a very good category.

Biotechnology e-comics complemented by factual videos integrated with science literacy on the topic of biotechnology have a weakness where students only focus on seeing images so that in the future it is hoped that students will really listen to biotechnology e-comics complemented by factual videos. Biotechnology e-comics equipped with factual videos are in printed form due to limited access to cellphones, so future research is expected to present biotechnology e-comics equipped with factual videos to be more practical in digital form such as PDF or animation using applications with more complete features. Suggestions for further research based on the results of the needs analysis that has been carried out, namely the need for interactive comic media on other Biology materials and the addition of features to interactive comics that can be used to improve science literacy in addition to providing overlapping conversations.

Author Contributions
All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest
The authors declare no conflict of interest. The authors declare that the work presented in this article is original and that they will bear any liability for claims relating to the content of this article.

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