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Development of Digital Comic Learning Media to Improve Conceptual Understanding of Human Respiratory System Material for Grade XI Students at SMA Negeri 3 Padangsidimpuan

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Abstract

The background of this study is based on the low interest in learning and student learning outcomes in Biology material which is abstract and the limited interesting and contextual learning media. This study aims to develop learning media in the form of digital comics as an effort to improve students' conceptual understanding of the human respiratory system material in class XI of SMA Negeri 3 Padangsidimpuan. The research method used is Research and Development (R&D) with the ADDIE (Analysis, Design, Development, Implementation, Evaluation) development model. The subjects of this study were students of class XI-3. The instruments used include validation questionnaires from media experts, material experts, language experts, teacher response questionnaires, student response questionnaires and conceptual understanding tests. The validation results show that the developed digital comics are categorized as very valid both in terms of content and media display with an average of 89.88%. The results of data analysis from the practicality questionnaire from teacher responses at SMA Negeri 1 Padangsidimpuan reached a percentage of 98% and the results of the student response questionnaire with a sample of 31 students reached an average value of 88.96% with a very practical category. Digital comic media, which is used to measure students' conceptual understanding of the human respiratory system material, is included in the effective category. The effectiveness of this digital comic media can be seen based on the N-Gain value of student learning outcomes, which is 56.04% with moderate criteria, and based on the results of the student effectiveness questionnaire using digital comic media, which is 87.66%. Product trials show that the use of digital comics can significantly improve students' conceptual understanding. Thus, this digital comic learning media is worthy of being used as an alternative learning media in the Biology learning process, especially in the human respiratory system material.

Keywords: Conceptual Understanding, Development, Digital Comics, Human Respiratory System, Learning Media,

INTRODUCTION

Education is a conscious and planned effort to prepare students to become individuals who are faithful, devoted to God Almighty, and have noble character, as well as being able to

develop themselves optimally. One important aspect of education is an effective learning process to achieve these goals. In this process, the use of learning media plays an important role as a tool to convey material in a way that is more interesting and easier for students to understand (Dewi & Ahadi, 2022; Harahap & Solihin, 2025). However, in reality, there are still many shortcomings in the use of media in the learning process (Solihin et al., 2025; Nasution & Aslan, 2025), especially at the senior high school level. The media used tends to be monotonous and lacking in variety, such as textbooks and blackboards, which are unable to attract students' attention. As a result, the learning process becomes less effective and has an impact on students' low understanding of the material being taught. (Yuniati at al., 2024).

One of the subjects that students often find difficult to understand is the human respiratory system. This subject contains scientific terms and abstract concepts, as well as complex mechanisms, which require media that can present these processes visually and in an interesting way. Without supporting media, students tend to have difficulty absorbing and understanding the material in depth (Ike & Rohman, 2024). The results of observations and interviews at SMA Negeri 3 Padangsidimpuan indicate that most students have difficulty understanding the concept of the respiratory system due to a lack of varied and interesting supporting media. They feel bored with learning that relies solely on books and verbal explanations from teachers. This results in suboptimal levels of understanding and learning outcomes among students.

Similarly, student activities during the learning process tend to be passive and inactive. Many students chat, play on their mobile phones, or even joke around during lessons. This situation indicates a lack of interest and motivation to learn the material presented, especially abstract and difficult-to-understand material. In addition to media-related factors, another challenge arises from the limited use of diverse and innovative learning resources. Teachers often face constraints in developing engaging teaching methods, resulting in a monotonous and boring learning process for students. As a consequence, students are less motivated to engage in active and comprehensive learning (Surati & Ariani, 2024).

In this context, the development of digital-based learning media such as digital comics can be an effective solution. Digital comics are able to present material visually, interactively, and enjoyably, making it easier for students to understand even difficult concepts. This media can also be accessed anytime and anywhere according to the needs of students (Maharani, 2022; Harahap, at al, 2023).

Digital comics have advantages such as being cheaper, more durable, easily accessible, and interactive. This can increase students' motivation to learn while helping them understand

the mechanisms of the respiratory system visually and concretely. Thus, it is hoped that students' understanding of the material will increase significantly (Megantari dkk., 2021). In addition to these benefits, the use of digital technology-based media can also help overcome the problem of passive student activity during the learning process. Interactive media can attract students' attention, trigger curiosity, and stimulate their active participation during the learning process. Thus, learning outcomes are expected to improve comprehensively (Sitepu, 2022).

The development of digital-based learning media, especially digital comics, is relevant for application in biology learning in senior high schools. Complex respiratory system material requires media that can simplify concepts and present clear illustrations so that students can easily understand them. This media can also increase students' interest and motivation in learning. Furthermore, the use of innovative and interesting media can help teachers deliver material more effectively. Teachers no longer need to spend a lot of time explaining abstract concepts because students can learn independently through the provided media. This aligns with the demands of modern digital-based education. (Syahmi at al., 2022).

Against this background, the development of digital comic learning media has become a necessity to improve the quality of the teaching and learning process, particularly in the subject of the human respiratory system, which often poses challenges for students' understanding. The use of this medium is expected to increase student engagement and motivation while improving their learning outcomes. Therefore, this research on the development of digital comic-based educational media is highly significant. The objective is to create an engaging, efficient, and effective medium to assist students in understanding difficult biological concepts and optimising their learning outcomes..

RESEARCH METHOD

The research and development (R&D) method used with ADDIE development contains five stages, namely analysis, design, development, implementation, and evaluation. The analysis stage aims to (1) analyse learning outcomes to determine students' knowledge of the human respiratory system, (2) analyse learning media characteristics to determine the criteria for digital comic learning media that are appropriate for students' learning styles in achieving learning objectives, and (3) analyse content. Content analysis relates to the content of digital comic learning media, namely that the material used is relevant to the applicable curriculum.

The design stage aims to design digital comic media. (1) Review of learning materials. At this stage, the material on the human respiratory system is determined and selected. (2)

Media design (flowchart) In this phase, the developer must select the location and learners from the setting to be tested, the content experts, learning experts, mastery test experts, and teaching module and learning media design experts.

The development stage is the process of creation using the Canva application. The implementation stage serves to refine the digital comic that has been developed. This refinement is carried out through two types of data, namely quantitative and qualitative data. Quantitative data is obtained from the accumulation of Likert scale scores from expert validators and student responses through validation instruments and student response questionnaires, with the final result in the form of a percentage. Meanwhile, qualitative data is obtained from suggestions and input from expert validators on the product validation sheet and input from students on the student response questionnaire sheet.

The final stage is evaluation, where the digital comic will be evaluated to determine its quality, value, and suitability for improving understanding of the concepts in the human respiratory system.

The population in this study was all students in grade XI at SMA Negeri 3 Padangsidimpuan, and the sample used was class XII-1 consisting of 31 students. The sampling technique used in this study was purposive sampling, which is a technique for determining samples based on specific criteria. (Sugiyono, 2023)

The instruments used include validation questionnaires for media experts, subject matter experts, language experts, teacher response questionnaires, student response questionnaires, and concept comprehension tests. The formulas and assessment indices applied are as shown in the table.

Table 1. Likert Scale and Validation Questionnaire Levels

Likert scale	Criteria (%)	Level of Validity
5	81 - 100	Highly valid, can be used without modification
4	61 - 80	Valid, usable but needs minor improvements
3	41 - 60	Sufficiently valid, needs major improvement, not recommended for use
2	21 - 40	Invalid, cannot be used
1	0 - 20	Not valid, should not be used

Table 1 shows the Likert scale and validation levels used in assessing digital comics in the research instrument. The Likert scale is used to measure the extent to which digital comics meet the established validation criteria, so that the digital comics produced are in accordance

with the desired validity standards before being used as a learning medium in research. The determination of the validity level is based on the data obtained, calculated using equation 1.

$$Value = \frac{Total\ Score\ Obtained}{Highest\ Score} \text{ x } 100\%$$

In the teacher and student response questionnaires, a Likert scale was used to avoid neutral results. A scale of indecision was not adopted so that the questionnaire was composed of positive and negative statements.

Table 2. Teacher Response and Student Response Instrument Scale

Criteria	Score
Very Good	5
Good	4
Enough	3
Low	2
Very Low	1

Table 2 shows how scores are given for statements that are very good and very poor so that the data does not appear neutral. Thus, the students' responses can be clearly categorised as positive or negative towards the statements in the instrument. The scores from the students' responses are calculated using equation 2

The final results of the students' responses are calculated using the average formula (mean).

$$Rpd = \frac{Rpd1 + Rpd2 + Rpd3 + \cdots + Rpdn}{N}$$

Description:

Rpd_n : Student response with n = 1, 2, 3, …n

Rpd : Average combined response of all students

N : Total Students

The practical results of the practicality analysis after the presentation level is known can be adjusted to the practicality assessment criteria modified from Riduwan as follows (Riduwan, 2016).

Table 3. Range and Criteria for Practicality Assessment

Description	Criteria (%)	Level of Validity
4,01 – 5,00	81 - 100	Very Practical
3,01 – 4,00	61 - 80	Practical
2,01 – 3,00	41 - 60	Quite practical
1,01 – 2,00	21 - 40	Impractical
0,00 – 1,00	0 - 20	Not practical

RESULTS AND DISCUSSION

Media, Material, and Language Validator Results

Overall, the percentage of media expert validation from Table 4 was 89.88% in the 'highly valid' category. The percentage was derived from the accumulation of aspects of material, media, and language. The sub-aspect of material received 88% with 'highly valid'. In terms of the clarity of the cover, comic illustrations, and the appeal of the comic, they were found to be appropriate. This is in line with the statement (Putra dkk., 2023, hlm. hlm. 503) The cover of a comic book is its face, so it serves as the first thing that catches the attention of students. (Narestuti & Nurjanah, 2021, hlm. hlm. 312) that the suitability of the illustrations on the cover and throughout the comic helps students represent specific forms or examples of the material being discussed.

Table 4. Overall Validation Results Data

No	Validation	Percentage	Category
1	Material Validator	88%	Highly Valid
2	Media Validator	90%	Highly Valid
3	Language Validator	91,66%	Highly Valid
	Average	**89,88%**	**Highly Valid**

Media expert validation

Table 5. Media Validation Results

No	Indicator	Score Expert	Max Score	P (%)	Criteria
1	The material presented is in accordance with the Basic Competencies (KD).	4	5	80	Valid
2	The material presented is in accordance with the Core Competencies (KI).	5	5	100	Highly Valid
3	Alignment of learning objectives with core competencies and basic competencies	4	5	80	Valid
4	Completeness of materials	4	5	80	Valid
5	Appropriateness of material to learning objectives	4	5	80	Valid
6	Clarity of material delivery	5	5	100	Highly Valid
7	Ease in understanding the material	4	5	80	Valid
8	Systematic presentation of material	4	5	80	Valid
9	Appropriateness of material for grade level	5	5	100	Highly Valid
10	The images used in digital comics are consistent with material discussed.	5	5	100	Highly Valid
	Total	**44**	**50**	**88%**	Highly Valid

Based on Table 5, the percentage obtained from subject matter experts was 88%, which is in the highly valid category and ready to be tested in the next stage. The learning media development product in the form of a softcopy, namely digital comics on the human respiratory system, has been submitted to a biology expert, Rafeah Husni, M.Pd, to validate the product that has been developed..

Subject Matter Expert Validation

The developed educational media product, a digital comic book on the human respiratory system, was submitted directly to media experts or lecturers specialising in educational media, namely Lia Junita Harahap, M.Pd.

Table 6. Results of Media Expert Assessment of Digital Comic Learning Media at Padangsidimpuan 3 State Senior High School

Aspect	No	Indicator	Score Expert	Score Max	P (%)	Criteria
Effectiveness	1	Effective and efficient in development	4	5	80	Valid
	2	Effective and efficient to use	5	5	100	Highly Valid
Suitable and targeted	3	The suitability of appearance, narrative, and language style in media with the characteristics of students' learning needs	4	5	80	Valid
Ease	4	Easy to understand material	5	5	100	Highly Valid
	5	Media is easy to use anytime, anywhere	5	5	100	Highly Valid
Presentation aspects	6	Clarity of text presentation in digital comics for easy understanding	5	5	100	Highly Valid
	7	Attractive image presentation	5	5	100	Highly Valid
Conformity	8	Accuracy of illustrations with the material	5	5	100	Highly Valid
	9	Color selection consistency	4	5	80	Valid
	10	Appropriateness of font selection	4	5	80	Valid
	11	Design layout suitability	4	5	80	Valid
	12	Balance of image proportions	5	5	100	Highly Valid
Neatness	13	Design neatness	4	5	80	Valid
	14	Text neatness in digital comics	4	5	80	Valid
Total			**63**	**70**	**90%**	**Highly Valid**

Based on Table 6, the percentage obtained from media experts was 90% in the highly valid category and ready to be tested in the next stage.

Language Expert Validation

The digital comic learning media on the human respiratory system was submitted directly to a language expert or lecturer specialising in learning media, namely Lia Junita Harahap, M.Pd. Based on the percentage obtained from the language expert, 91.66% was classified as highly valid and ready for testing in the next stage, as shown in Table 7 below.

Table 7. Results of Language Experts' Assessment of Digital Comic Learning Media at Padangsidimpuan 3 State Senior High School

No	Indicator	Score Expert	Skor Maks	P (%)	Criteria
1	Accuracy of sentence structure in digital comic learning media packaging to improve students' understanding of the human respiratory system in Grade XI high school	5	5	100	Highly Valid
2	The standardisation of terminology in digital comic learning media to improve students' understanding of the human respiratory system in Grade XI Senior High School	4	5	80	Valid
3	The effectiveness of sentences in digital comic learning media to improve students' understanding of the human respiratory system in Grade XI Senior High School	5	5	100	Highly Valid
4	The placement of animated language in the packaging of digital comic learning media to improve students' conceptual understanding of the human respiratory system in Grade XI high school	4	5	80	Valid
5	The appropriateness of language according to KBBI standards in digital comic learning media to improve students' conceptual	4	5	80	Valid

	understanding of the human respiratory system in Grade XI high school				
6	Clarity of narrator language in digital comic learning media packaging to improve students' conceptual understanding of the human respiratory system in Grade XI high school	5	5	100	Highly Valid
7	Appropriateness of language placement in digital comic learning media to improve students' conceptual understanding of the human respiratory system in Grade XI high school	5	5	100	Highly Valid
8	Accuracy of spelling in media	4	5	80	Valid
9	Ease of understanding the language used in media	5	5	100	Highly Valid
10	Alignment with students' intellectual development	4	5	80	Valid
11	Accuracy of punctuation in digital comics	5	5	100	Highly Valid
12	Standardisation of sentences used in digital comics	5	5	100	Sangat Valid
	Total	**55**	**60**	**91,66%**	**Highly Valid**

Based on the average responses of teachers and students regarding the use of digital comic learning media, the practicality of the media can be seen as follows:

Table 8. Average Practicality of Digital Comic Media

Response	Percentage of Practicality
Teacher Response	98 %
Student Response	88,96 %
Average	**93,48 %**

Advantages and Disadvantages of Expert Validators

The advantages and disadvantages of digital comics according to subject matter experts, media experts, and language experts are as follows:

Table 9. Strengths and Weaknesses of Digital Comics According to Validators

Validation	Advantages	Weakness
Subject Matter Expert	The material in this digital comic has been arranged in a logical sequence and is in accordance with the applicable curriculum.	Some parts of the material are still not in-depth enough, especially the core concepts which should be explained more clearly.
Media Expert	The visual display is very attractive and colourful..	There are some panels that are too dense with text, which can reduce reading comfort.
Language Expert	The language used is quite communicative and appropriate for the characteristics of the students..	There are still some spelling and punctuation errors..

CONCLUSION

Based on the results of the development of digital comic learning media, it can be concluded that digital comics have met the validity criteria in instilling the concept of the human respiratory system by subject matter experts, media experts, and language experts. The expert validation results state that the digital comic learning media is 'Highly Valid' in the validity test with a validity percentage of 89.88%. The digital comic media meets the practicality criteria in instilling the concept of the human respiratory system by teachers and students. The results of the teacher response questionnaire in the field trial showed an average score of 98% in the very practical category. Meanwhile, the results of the student response questionnaire in the field trial obtained an average score of 88.96% in the 'very practical' category.

Therefore, overall, the developed media was declared 'Very Practical' with an average combined percentage of 93.48%. The digital comic media meets the 'Effective' criteria in instilling an understanding of the human respiratory system. Based on the N-Gain learning outcomes of students, which was 56.04%, it falls under the 'Moderate' criterion. The digital comic media meets the 'Effective' criterion in instilling an understanding of the human respiratory system. Based on the effectiveness survey results of students using the digital comic media, the score was 87.66%.

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