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Human Blood Circular System Educational Digital Comics for Improving Learning Outcomes

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Abstract: The learning outcomes of class V at SDN Bendungan Semarang in science subjects on the human circulatory system are low. The average learning outcome of fifth-grade students at SDN Bendungan is 63, where the score is less than the standard of minimum value for science subjects, namely 75. This study aims to develop the learning media "Digital Comics for Education on the Human Circulatory System" as well as to test the design of media development, test the feasibility of media, as well as to find out the effectiveness of the learning media "Digital Comic Education for the Human Blood Circulation System." The method used in this study is the Research and Development method with the Borg and Gall development model. The subjects in this research and development were: (1) Grade V students at SDN Bendungan Semarang in the 2022/2023 school year with 28 students; (2) Class V teachers at SDN Bendungan; (3) experts, expert lecturers, or experts as testers of learning media and provide input to the learning media. Data collection techniques are questionnaires, interviews, documentation, observation, and tests. Data analysis used validity, reliability, normality, t-tests, and N-gain tests. Based on the study's results, suitable for use with a percentage of material experts' assessment of 86% and a percentage of media experts' assessment of 95%. The percentage of teacher responses is 91%, and the percentage of student responses is 89%. The t-test result is 0.000, so there is a significant difference between the pretest and the post-test results. The result of the N-gain test is 0.60957 in the medium criteria category. So that the results obtained are: (1) the design of learning media that is developed according to the needs of students and teachers in teaching and learning activities; (2) the assessment of media experts and material experts with very feasible criteria; (3) the use of effective learning media in increasing student effectiveness and motivation. Based on the responses of teachers and students, the results of the study show that learning media is appropriate for use in teaching and learning activities.

Keywords: Development; Digital Comics; Human Blood; Learning Media.

Introduction

Learning is one of the needs of students at this time (Carlson et al., 2019). Learning is very important for students because by learning, students can gain knowledge (Harefa & Sarumaha, 2020). Indonesia has established regulations that studying is one of the obligations regulated in Article 5 paragraph (2) of the 1945 Constitution of the Republic of Indonesia and the Law of the Republic of Indonesia Number 20 of 2003 concerning the National Education System (Adiwijaya, 2022). According to Alam (2022), learning is a process carried out by a person to get a change in behavior that is new as a whole, which is the result of his own experience with interaction with his environment (Kaufmann & Vallade, 2022). Learning is a process of changing behavior based on experience and has a relatively permanent impact (Schuman-Olivier et al., 2020). The definition of learning, according to Ransbotham et al. (2020), is an activity in which there is a process for those who don't understand to understand, can't, to be able to achieve optimal results (Kasumawati, 2021). Based on some of these opinions, learning is a process carried out by students so that students get changes in behavior based on experience, and have a relatively permanent impact on students. In teaching and learning activities, things are needed that help

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learning run effectively. One way to learn to run effectively is to use the media.

Learning media are all intermediaries used by humans who can spread or convey opinions, ideas, or ideas put forward to the intended recipient (Kumala et al., 2023). Learning media is a means that can support teaching and learning activities properly and effectively (Widianto, 2021; Zaini & Dewi, 2017). Learning media in teaching and learning activities can generate enthusiasm, interest in learning, and student motivation (Dwijuliani et al., 2021; Rahim et al., 2022). Learning media can be in the form of visual media (Puspitarini & Hanif, 2019). Visual media can be seen using the sense of sight, namely the eyes (Jarodzka et al., 2021). Visual media has an important role in the learning process because visual media can strengthen student memory, facilitate student memory, and visual media can foster student interest in learning (Nugrahani, 2007). As technology develops, many visual media can be used in teaching and learning activities. One visual medium that can be used in learning is comics.

Comics are pictures in a cartoon style that contain a visual representation of the idea of a subject. The comics are visual media in the form of pictures lined up in a deliberate sequence used to convey information and generate responses to readers (Baga et al., 2022; Riwanto & Wulandari, 2019; Udayani et al., 2021). Comics are a product of the development of book history. Comics are learning media that can be used in learning (Vilaça, 2022). Educational comics convey information related to a material in the learning (Kaur, 2023). Digital comics develop images and illustrations that have a specific story. Images or illustrations presented in digital comics explain the material in the comics (Setiawan et al., 2022). Ningsih et al. (2022)) states that comics must use good words in narration and dialogue. Narration and dialogue are placed on each comic panel (Fathurrahman et al., 2021). The statement, it can be seen that educational digital comics are comics that develop images or illustrations related to a material used to educate and convey information to readers.

Based on the observation activities carried out before starting the research. It was found that the learning outcomes of fifth-grade students at SDN Bendungan Semarang were still low. Based on learning outcomes, 22 students still needed to fulfill the standard of minimum value for science subjects with a score of 75. Meanwhile, six students fulfilled the standard minimum of value for science subjects.

Low student learning outcomes in science subjects are because most students perceive science as difficult, so student scores are not maximized. Another problem that causes low student learning outcomes in science subjects is the need for more learning media in teaching and learning activities. This problem was also found in SDN Bendungan Semarang, especially class V SDN Bendungan Semarang, due to the need for more learning media in teaching and learning activities. Based on the interview results with the class V teacher, SDN Bendungan Semarang. The learning media used is printed books. Because learning only uses printed books, students are less interested in participating in learning. Based on these problems, researchers developed the learning media "Digital Comics for Education of the Human Circulatory System."

Method

The research method used by researchers is the method of research and development (Research and Development). The Research and Development research model researchers use is the one developed by Borg and Gall (Maharani et al., 2019). Borg and Gall state that the research and development method is developing and validating educational products. The research and development method attempts to develop and validate the products used in teaching and learning activities. (Full Moon 2016). According to Borg and Gall, products in research and development are not limited to material materials, such as books or texts, but also learning media (Ilmiawan & Arif, 2018). In the Research and Development research method, researchers developed a product in the form of learning media, "Digital Comics for Education of the Human Circulatory System."

The development research model, according to Borg and Gall in (Sugiyono, 2015), summarizes the steps of development research with steps (1) potential and problems, (2) data collection, (3) product design, (4) design validation, (5) design revision, (6) use trials, (7) product revisions, (8) product trials, (9) product revisions, and (10) manufacture of mass production. (Kurniawan, 2021).

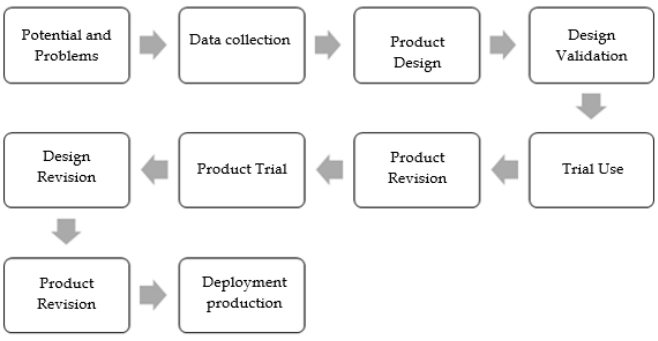

Figure 1. Research and Development Steps

The subjects in this research and development were 1) Class V students at SDN Bendungan Semarang in the 2022/2023 school year and 2) Class V teachers at SDN Bendungan. Those who play a role in gathering

information and carrying out science learning use the learning media "Digital Comics for Education on the Human Circulatory System" developed by researchers 3) Experts, expert lecturers, or experts as testers of learning media and provide input to the learning media "Digital Comics for Education on the Circulatory System Man."

Data collection techniques were carried out in collecting research data by using tests and notes. The non-test instruments used were interviews, questionnaires, and documentation. The test instruments used were tests carried out at the beginning of learning (pretest) and tests carried out at the end of learning (posttest) as a comparison to increase student learning outcomes in class V SDN Bendungan Semarang, before and after using "Digital Comic Education for the Human Circulatory System."

Table 1. Likert Scale Score

Criteria	Score
Very Good	4
Good	3
Enough	2
Less	1

Data analysis used in this development research consisted of three types, including due diligence analysis, initial data analysis, and final data analysis. The feasibility test analysis assessed the research products carried out by expert validators using a Likert scale. Preliminary data analysis was used to determine the effectiveness of students' pretest and posttest results by analyzing student learning outcomes using the normality test. Analysis of the final data was used to find out the differences in the average pretest and posttest of students and to test the differences in learning outcomes in the average pretest and posttest on the use of learning media "Digital Comics Education for the Human Circulatory System" using the t-test and the N-test gain to determine the average increase in student learning outcomes. Furthermore, the feasibility research instrument of learning media is analyzed using the Formula 1. The percentage results of the feasibility data are then converted with the due diligence criteria.

$$P = \frac{f}{N} \times 100\% \quad (1)$$

Table 2. Due Diligence Criteria

Percentage (%)	Criteria
86 – 100	Very Worth It
76 - 85	Worthy
60 – 75	Decent Enough
55 - 59	Less Eligible
<54	Not Feasible

Preliminary Data Analysis

Preliminary data analysis was carried out descriptively regarding the level of needs of teachers and students regarding learning media "Digital Comics for Education of the Human Circulatory System" in class V. Initial data analysis was calculated using the normality test. The normality test was carried out to test students' pre-test and post-test learning outcomes. The purpose of the normality test is to determine whether the pre-test and post-test data are normally distributed. The SPSS application is used to determine the results of the normality test.

Final data analysis

The final data analysis was used to determine the effect of using learning media "Digital Comic Education for the Human Circulatory System" calculated using the t-test and the N-Gain test. The t-test is calculated using the SPSS application. Furthermore, the N-gain test is used to calculate the data by Formula 2.

$$N - Gain = \frac{Post\ test\ score - Pretest\ score}{SM1 - Pretest\ score} \quad (2)$$

To determine the magnitude of the high and low N-gain values seen by the table of criteria for increasing learning outcomes.

Tabel 3. Criteria for Increasing Learning Outcomes

Interval	Criteria
N-gain < 0.3	Low
0.3 < gain < 0.7	Moderate
N-gain > 0.7	High

The independent variable in this study was the learning media "Digital Comic Education for the Human Circulatory System," while the dependent variable was learning outcomes.

Result and Discussion

The learning media developed by researchers is "Digital Comic Education for the Human Circulatory System" to improve learning outcomes for fifth-grade students at SDN Bendungan Semarang. The researcher developed the learning media (Maulinda et al., 2023) "Digital Comic Education for the Human Circulatory System." The media developed by this researcher is used as a learning medium that helps students in teaching and learning activities. This research adapts the development research model proposed by Borg and Gall; the following are the steps studied in development research.

Potential and Problems

The initial step taken by researchers is to find potential and existing problems. The potential and problem stages are obtained from interviews and observations researchers have conducted. Based on observations and interviews conducted by researchers with fifth-grade teachers at SDN Bendungan Semarang, it was found that during the learning process, students were less enthusiastic about participating in existing learning; this was because, in learning, the teacher only used printed book media. Based on document data on the learning outcomes of fifth-grade students at SDN Bendungan Semarang, it shows that the learning outcomes of fifth-grade students at SDN Bendungan Semarang are still low because out of 28 students, only 6 students whose grades meet the standard of minimum value 75. In comparison, 22 other students still need to meet the standard of minimum value.

Data collection

Researchers collected data related to media development through direct interviews with fifth-grade teachers at SDN Bendungan Semarang. In addition, researchers also collected data related to media development by giving questionnaires to students' needs and teachers' needs questionnaires. Furthermore, the questionnaire was filled out by students and teachers. The purpose of completing the teacher and student needs questionnaire is to collect information related to product planning to be developed by researchers.

Product Design

The design for developing educational digital comic media is adapted to the questionnaire analysis of the needs of students and teachers. The material presented in educational digital comics is adapted to core competencies, basic competencies, indicators, and learning objectives that must be conveyed to clarify the material to be delivered. Learning evaluation is outlined in the Learning Implementation Plan, which will be used for learning. Based on the results of interviews with the teacher, the use of learning media "Digital Comics for Education on the Human Circulatory System" can assist students in carrying out learning activities, as well as facilitate the delivery of material on the human circulatory system, to increase student motivation and learning outcomes.

The media used in "Digital Comics for Human Circulatory System Education" is PDF (Portable Document Format). The letter or font used is Bryann White. The colors are bright because students prefer brightly colored pictures to black and white. The speech bubble's location is to the character's right and left. The characters used are figures made by researchers with the theme of learning together in class. There are several parts in the design of the development of learning media "Digital Comics for Education of the Human Circulatory System," namely: (1) front cover, (2) instructions for using educational digital comics, (3) core competencies, basic competencies, and learning objectives, (4) character introduction, (5) learning materials (6) quizzes, (7) concept maps (8) bibliography, (9) author profiles.

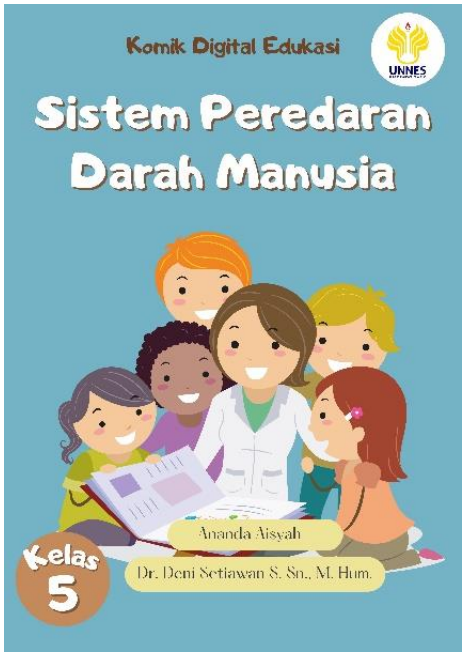

Figure 2. Cover Learning Media Digital Comics for Human Circulatory System Education

Design Validation

Design validation is needed as a step to assess if the product being developed is feasible to be tested or not feasible to be tested. After the product design developed by the researcher has been completed, then design validation will be carried out by material experts and media experts (Maskur et al., 2017). Before being used as learning media in class V SDN Bendungan, two expert validators, namely material experts and media experts, assessed the learning media "Digital Comics Education for the Human Circulatory System." The purpose of validation by material and media experts is to determine whether the media that researchers will develop is valid. Product design development validated by material and media experts includes material, language, and media aspects. Researchers gave questionnaires to material experts and media experts. The researcher used a Likert scale of 1 to 4 to fill out the questionnaire. The material and media experts then ticked the statements the researcher gave. After giving a tick, material experts and media experts also provide criticism and suggestions that can be used as improvements and revisions to the design of learning media.

Design Revision

After carrying out design validation with material and media experts, the researcher received input, criticism, and suggestions from material and media experts. Design revision is necessary because the feasibility of the product developed by the researcher is inseparable from the criticism, suggestions, and input provided by material experts and media experts.

Small Scale Test

The learning media "Digital Comic Education for the Human Circulatory System," which had been revised, was then carried out on a small-scale test and tested on 5 grade V students at SDN Bendungan Semarang. This small-scale trial aimed to see students' responses regarding the use of the learning media "Digital Comics for Education of the Human Circulatory System." In small-scale trials, researchers gave pretest questions to students.

Table 4. Small Scale Test

Action	N	Mean	Difference	N-gain Score	Criteria
Pretest	5	64.00	23.00	0.61	Medium
Posttest	5	87.00			

Based on the small-scale test table, there is an increase in the average student learning outcomes after carrying out learning using the learning media "Digital Comics for Education of the Human Circulatory System." The average pretest score is 64, and the posttest average score is 87, with the difference between the posttest and pretest scores being 23. The results of the N-gain test show a value of 0.6063 in the medium category, so using learning media effectively improves student learning outcomes.

Product Revision

At the product revision stage, the researcher revised the product being developed, namely the learning media "Digital Comic Education for the Human Circulatory System," by paying attention to the responses of teachers and students who had been given the use of learning media. However, based on the responses of students and teachers, there is no need to revise the learning media. So that the learning media "Digital Comic Education for the Human Circulatory System" is declared feasible as a learning medium and can be continued to the next stage, namely the usage trial stage.

Usage Trial

After conducting a small-scale trial, a large-scale trial was carried out on fifth-grade students at SDN Bendungan Semarang, totaling 23 students. Before the researchers gave the learning media "Digital Comics for the Education of the Human Circulatory System" to students, the students did the pretest first. After working on the pretest, the researchers gave lessons to 23 students with material on the human circulatory system, using the learning media "Digital Comic Education for the Human Circulatory System" as a learning medium that assists in teaching and learning activities. Learning is carried out by the lesson plans that previous researchers have prepared. After carrying out the learning activities, then students do the posttest. After learning, students, and teachers completed a response questionnaire regarding the learning media "Digital Comics for Education of the Human Circulatory System." Researchers will use the response questionnaire to determine the effectiveness of learning media.

Deployment Production

The final product of this research is the learning media "Digital Comics for Education of the Human Circulatory System," which has been validated by material experts and media experts, with suggestions from teachers and grade V students. So that the learning media "Digital Comics for Education of the Human Circulatory System" can be used as a learning medium that supports learning science class V SDN Bendungan Semarang.

Data analysis

Feasibility of Learning Media "Digital Comics for Education of the Human Circulatory System"

Material experts in validating material on the "Digital Educational Comics" learning media are lecturers majoring in Elementary School Teacher Education at the Faculty of Education, Semarang State University, teaching natural science courses. The aspects validated by material experts are (1) the feasibility of the material, (2) the feasibility of the language of the material, and (3) the feasibility of presenting the material. The media expert in validating the learning media "Digital Comics for Education on the Human Circulatory System" is a lecturer majoring in Educational Technology Curriculum, Faculty of Education, Semarang State University. The aspects validated by media experts on the learning media "Digital Comics for Human Circulatory System Education" are (1) pictures/illustrations, (2) display, (3) media use, and (4) media convenience.

Tabel 5. Learning Media Feasibility Assessment

Expert	Total Score	Gain Score	Percentage (%)	Information
Material	80	69	86	Very Woth It
Media	80	76	95	Very Worth It

Based on the assessment by material experts, they got a score of 69 out of a total score of 80, with a percentage of 86%. So the learning media "Digital Comics for Education of the Human Circulatory System" are included in the criteria that are very suitable for use as learning media. The material expert's assessment results were then analyzed and considered for revising the learning media "Digital Comics for the Education of the Human Circulatory System" so that the media could be developed better. Improvements that need to be corrected in the learning media "Digital Comic Education for the Human Circulatory System" are (1) formulation of introductory objectives, (2) closing of comics, (3) need to include character introduction, (4) adjustment of background or background on digital comics.

Based on the assessment that media experts have given, a score of 76 out of a total score of 80 is obtained with a percentage of 95%, so the learning media "Digital Comics for Education of the Human Circulatory System" is very suitable for use as a learning medium. The media expert's assessment results were then analyzed and considered for revising the learning media "Digital Comics for Education of the Human Circulatory System" so that the media could be developed better. The improvement that needs to be fixed in the learning media "Digital Comics for Education on the Human Circulatory System" needs to include an academic identity in the form of the Semarang State University logo on the cover page.

Media Effectiveness

The effectiveness of the learning media "Digital Comics for Education on the Human Circulatory System" was measured using the t-test and the N-gain test. Before carrying out the t-test, a normality test was carried out first.

Table 6. Normality Test Results for Pretest and Posttest Values

		Unstandardized Residual
N		23
Normal Parameters	Mean	0.0000000
	Std. Deviation	8.26054036
Most Extreme Differences	Absolute	0.132
	Positive	0.132
	Negative	-0.085
Test Statistic		0.132
Asym. Sig. (2-tailed)		0.200

Based on the results of the normality test, it can be seen that if the significance value is 0.200> 0.05, the residual values are normally distributed. After the normality test was carried out, then the t-test and N-gain test was carried out.

Table 7. Pretest and Posttest t-test results

Act	N	Mean	Std. Deviation	Std. Error Mean	t	df	Sig.
Pretest	28	51.52	15.985	3.333	-12.668	22	0.000
Posttest	28	79.35	12.550	2.617			

The significance value (2-tailed) of the data is 0.000. So there is a significant difference between the pretest scores and posttest scores. So it significantly influences students' posttest scores after using the learning media "Digital Comics for Education of the Human Circulatory System."

After carrying out the t test, the next step is to carry out the N-gain test.

Table 8. N-gain Test Results

Act	N	Mean	Difference	N-gain Score	Criteria
Pretest	23	51.52	27.83	0.609507	Medium
Posttest	23	79.35			

The mean value obtained is 0.6095, and the value is 0.3 <0.6095 <0.7, so it is in the medium category. Hence, the use of learning media "Digital Comics for Education of the Human Circulatory System" effectively improves learning outcomes in fifth-grade students at SDN Bendungan Semarang.

Student and Teacher Response Questionnaire

After researching the learning media "Digital Comics for the Education of the Human Circulatory System," the researchers then gave a response questionnaire to teachers and students.

Table 9. Student and Teacher Response Questionnaire

Response	Score	Percentage (%)	Information
Students	1239	89	Very good
Teacher	55	91	Very good

The total student score from the student response questionnaire was 1239 out of a total score of 1380 with a percentage of 89% with very good criteria. The total score of the teacher is 55 out of a total score of 60, with a percentage of 91% with very good criteria.

Conclusion

This research develops learning media "Digital Comics for Education of the Human Circulatory

System." The media used in "Digital Comics for Human Circulatory System Education" is PDF (Portable Document Format). The letter or font used is Bryann White. The colors used are bright colors because students prefer brightly colored pictures compared to black and white. The location of the speech bubble is to the right and left of the character. The characters used are figures made by researchers with the theme of learning together in class. There are several parts in the design of the development of learning media "Digital Comics for Education of the Human Circulatory System," namely: (1) front cover, (2) instructions for using educational digital comics, (3) core competencies, basic competencies, and learning objectives, (4) character introduction, (5) learning materials (6) quizzes, (7) concept maps (8) bibliography, (9) author profiles. Learning media developed by researchers get a percentage of 86% from material experts and 95% from media experts, so the learning media "Digital Comics Education of the Human Circulatory System" is very feasible to use in supporting learning. The learning media "Digital Comics for Education on the Human Circulatory System" is effective on student learning outcomes with a significance value (2-tailed). Data from the t-test is 0.000. So there is a significant difference between the pretest scores and posttest scores. So it shows that there is a significant influence on students' posttest scores after using the learning media "Digital Comics for Education of the Human Circulatory System." The results of the N-gain test, the mean value obtained is 0.6095, the value is 0.3 <0.6095 <0.7, so it is in the medium category, so the use of learning media "Digital Comics for Education of the Human Circulatory System" is effective in improving the learning outcomes of fifth-grade students at SDN Bendungan Semarang.

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Author Contributions
Ananda Aisyah, as the first writer, played the role of data collector and manager in the field, survey team, and part of the administration team at SDN Bendungan Semarang. Aisyah also served as a member of the data collection and survey team, as well as conducting interviews with teachers. Deni Setiawan, as the second writer, who manages and conducts data analysis. Setiawan also served as a member of the data collection and survey team, as well as conducting interviews with the school principal.

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Conflicts of Interest
We declare that the authors in this article do not have a conflict of interest with anyone, either individual or any institution. We are writing as part of reporting research activities and contributions to science.

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