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Development of Human Blood Circulation Board Media (PAPEDA) Oriented to Students' Mastery of Science Concepts

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Abstract: This research aims to produce human blood circulation board media (PAPEDA) based on validity, practicality and effectiveness regarding students' mastery of science concepts. This research is development research. The development model used is the ADDIE model (Analysis, Design, Development, Implementation, Evaluation). The research subjects were 25 grade 5 students at SDN 14 Cakranegara. The instruments used were validation sheets, teacher assessment sheets, student assessment sheets, and test questions for students' mastery of science concepts. The data analysis technique used is a validity test with the minimum criteria being in the valid category, then a practicality test based on the results of teacher assessment and student assessment with the minimum standards being in the practical type, and an effectiveness test with the criterion that the proportion of students who achieve the classical minimum completeness criteria is at least at 75%. This research shows that PAPEDA learning media meets valid criteria with an average expert assessment score of 84% with perfect measures. The results of field trials show that PAPEDA learning media meets practical and influential standards. The functional aspect assessment was obtained from teacher and student assessments, with average scores of 96% (efficient) and 81% (efficient). The effectiveness aspect is evaluated from the results of students' mastery of science concepts tests. The proportion of students who reach the minimum completeness criteria in the science concept mastery test is 80%, within the effective criteria. Thus, the learning media developed meets valid, practical and influential standards.

Keywords: Elementary school; Mastery of science concepts; PAPEDA media.

Introduction

According to Piaget, in the theory of cognitive development, elementary school age enters the concrete operational stage. Students can think logically, understand concepts, organize objects into classifications, remember, understand, and solve substantial problems. In students' cognitive development, it is hoped that their learning will be meaningful. Meaningful learning involves new meaning from the material presented.

Meaningful learning is not synonymous with a meaningful understanding of material (de Farias, 2022; Polman et al., 2021). First, teaching materials have the potential to be significant. Second, considerable learning tools must exist. The learning tools needed are RPP, media, LKPD and evaluation instruments. One tool is the availability and use of concrete learning media in learning, which will provide more meaningful education.

Learning media makes it easier for students to understand and master concepts. The learning media is designed to be as concrete as possible to depict the original form or be close to the real object. Learning media can be an introduction or intermediary for the message you want to convey.

However, in reality, at SDN 14 Cakranegara, based on interviews with teachers in class 5, it was stated that learning media had been used. Still, they often needed help with the availability and use of natural media, such as the original form in science lesson content. This difficulty is experienced primarily in human blood circulation materials because the media is expensive. Even though they have used video media, they have yet to maximize students' activeness and involvement in learning. Video media is only for listening to the

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broadcast; it requires a medium that students can try and observe directly, as in the original. Image media has also been used for visualization; no concrete press has been created and used on human blood circulation material.

By trying and actively involving students, it is hoped that learning will become more meaningful. So that students' understanding of concepts and mastery of concepts regarding blood circulation in humans fulfills the KKM. This provides students with a performance by directly experiencing the blood circulation process in their bodies, so they are expected to appreciate and love their bodies more.

Concrete media makes fostering students' mastery of concepts easier because the press resembles the original form. The media is real and resembles the blood circulation process. Good understanding and knowledge of concepts will determine students' attitudes and behaviour and be critical in solving problems in their lives.

Students sometimes memorise concept definitions quicker than paying attention to the relationship between one concept and another. The result is that the new concept is not included in the existing concept, but the concept needs to be related to other concepts. So, the new concept cannot be used by students and has no meaning because the importance of the concept comes from its relationship with other concepts (Ermiana et al., 2022). Understanding concepts can be interpreted as the ability to absorb meaning, such as being able to explain a problem by presenting the problem in a form that can be understood; able to provide clarification and implementing it (Fiteriani, 2017; Panjaitan et al., 2015; Tangkas, 2014).

After students understand the concept, mastery of science concepts is students' ability to answer a series of questions in the form of a test. Concept mastery from the view of Joyce et al. (1996) states that concept mastery requires students to know the attributes of categories already existing in other people's minds by comparing and contrasting examples of these concepts.

The constructivist view states that mastery of scientific concepts is demonstrated by students by their ability to express their thoughts and views in the form of language. Students who demonstrate good mastery of concepts will be able to answer questions well regarding the material or skills they have learned. Based on the above, it is necessary to develop media to help solve the above problems.

Mastery of scientific concepts is a person's ability to understand, master, and apply basic concepts in natural science (Gomba, 2019; Handika & Wangid, 2013; Syahri et al., 2021). Several factors influence the mastery of scientific concepts, such as cognitive factors, namely how students can think abstractly and solve problems. Then, social factors, such as students' interactions with teachers and peers, and environmental factors, such as learning designs using technology and manipulative learning media (Jamaludin et al., 2022; Siahaan et al., 2020). Some indicators of mastery of scientific concepts are explaining scientific concepts in your own words and giving relevant examples, being able to apply scientific concepts in new contexts or problem situations, being able to use scientific concepts to solve problems, being able to make scientific arguments, being able to think critically, able to work together in groups involving scientific concepts, and able to analyze and interpret data in a scientific context (Net et al., 2023).

One of the concrete object media that can be used to strengthen scientific concepts is the blood circulation board media or what is abbreviated as PAPEDA. This human blood circulation board learning media is one of the learning media teachers can use to help the teaching and learning process. According to Tifanie et al., (2013) learning media can help teachers and students in the learning and teaching process because the media used is exciting and easy to understand for 5th-grade elementary school students. Nadori & Hoyi, (2021) also stated that using three-dimensional media or teaching aids on the human circulatory system can improve student learning outcomes. So, using learning media can help students understand the material and concepts of the human circulatory system and improve elementary school students' results and mastery of science concepts. On the other hand, the role of teachers in mastering science concepts is very important to help students develop good mastery of science concepts, including through effective and innovative teaching strategies supported by good teaching aids according to the needs and characteristics of students (Wilujeng et al., 2020; Daniah, 2020; W. R. Hidayati & Suryana, 2021).

Based on the above, it is necessary to develop media to help solve the above problems. One of them is creating a media board about human blood circulation, which can develop students' mastery of science concepts. Human blood circulation board media is essential to develop because, in its implementation, students are able to try and observe every flow of blood circulation that passes through every organ. Manipulative learning media can be used to assist teachers in delivering material to strengthen mastery of the concepts of the material presented (Hidayah et al., 2018). Apart from that, the importance of research on developing human blood circulation board media is because teachers use no manipulative media to convey this material. After all, so far, teachers have only relied on textbooks and video media, so the direct involvement of students in trying and observing blood circulation flow is still lacking. Therefore, this development research aims to produce human blood circulation board media oriented toward students' mastery of scientific concepts based on validity, practicality, and effectiveness.

Method

The type of research used is research and development. In this research, what was produced was a product in the form of a human blood circulation board media oriented towards students' mastery of science concepts. The research and development model used is the ADDIE model, which stands for Analyze, Design, Development, Implementation, and Evaluation. The ADDIE development model consists of five stages: analysis, design, development, implementation and evaluation.

The data collection instruments used in this research consisted of validation questionnaires, product practicality questionnaires, and science concept mastery test questions. The validation questionnaire is in the form of an assessment sheet, which will be given to media expert validators and material expert validators to assess whether the media product that has been developed is suitable or not suitable for use. Then, the practicality questionnaire is a teacher response assessment sheet used to determine the practicality of the PAPEDA media used in the classroom learning process. Meanwhile, the test question instrument is used to see the ability to master science concepts after learning using PAPEDA media.

The data collected from the research results will then be analyzed to answer the research problem formulation regarding product quality, developed in validity, practicality and effectiveness. The following are the criteria for the validity and practicality of the learning media developed.

Table 1. Validity and Practicality Criteria

Achievement Level	Validity criteria	Practicality criteria
81%-100%	Very valid	Very practical
61%-80%	Valid	Practical
41%-60%	Quite valid	Quite practical
21%-40%	Less valid	Less practical
1%-21%	Invalid	Inpractical

The PAPEDA media developed is valid if the validator assessment results are within the suitable criteria. Then, in the practical aspect, the moulded product is applicable based on the assessment of teachers and students if it meets the minimum standards of being in the suitable interval. Data obtained from the results of science concept mastery tests are analyzed to determine the effectiveness of the product being developed. The quality of the effectiveness aspect is seen based on the percentage of students who meet the minimum completeness criteria in the test of students' mastery of science concepts. The effectiveness criteria can be seen in the following Table 2.

Table 2. media effectiveness criteria

Completeness percentage	Effectiveness criteria
$p > 80$	Very effective
$60 < p \leq 80$	Effective
$40 < p \leq 60$	Quite effective
$20 < p \leq 40$	Less effective
$p \leq 20$	Not effective

(Widoyoko, 2009)

The product being developed is declared to have a good level of effectiveness if the minimum percentage of completeness obtained is within the effective criteria or the percentage of students who meet the minimum completeness criteria is 60<p≤80.

The flow of this research is as follows: 1) a preliminary study was conducted to collect initial data by conducting interviews, observations, and literature studies to analyze problems in the field; 2) carry out development design in the form of a prototype of the media product being developed; 3) develop media based on the results of the planned prototype; 4) carry out expert validation by involving 2 experts to obtain feasibility scores and improvement suggestions; 5) make media improvements based on expert advice; 6) implementation of media that has been developed in target schools; 7) conducting tests to determine students' ability to master science concepts to see the effectiveness of the media being developed; 8) carry out assessments on teachers and students to determine the practicality of the media being developed; 9) carry out revisions based on the teacher's assessment of the media; 10) analyze data based on the results of validation, test, and teacher and student response scores; 11) conclude.

Result and Discussion

Research Result

The PAPEDA media development procedure was carried out in this research using the ADDIE development model. The ADDIE development model consists of five stages: analysis, design, development, implementation and evaluation. A description of the development stages is as follows.

Analysis

The analysis stage consists of needs, student, and material analysis. A needs analysis is carried out to see the conditions in the field regarding the media needs needed for learning. Observation and interviews with teachers carried out requirements analysis. Based on the results of observations and interviews with teachers, the use of learning media has been carried out. However, there are still difficulties in providing media that resembles the original form of science lesson content in class 5. Even though video media has been used, it has yet to maximize students' activeness and involvement in learning. The use of video media is only to listen to the

broadcast without being directly involved in trying to observe now. Image media has also been used, but more for visualization only. There has not been any concrete media created and used on human blood circulation material. Still, it has yet to be optimal, so media that emphasizes student involvement in trying and observing directly is needed.

Analysis of student characteristics regarding cognitive development where elementary school students are generally aged 7-12. Elementary school students are still at the concrete operational stage at this age. Cognitive development has a substantial active step marked by the action of organized and rational thinking, so a learning media is needed that involves students directly in cognitive development. This is one of the reasons researchers developed concrete learning media to support students' understanding of science concepts, especially in science content regarding the human circulatory system. The application of the PAPEDA media makes it an experience for students to try and directly observe the blood circulatory system in the human body.

This research will develop a concrete learning media on science content by focusing on material on the human circulatory system. The learning media in this material is only limited to animated videos and pictures used by teachers, so a media product for the human circulatory system or what is known as PAPEDA media was developed. The material on the human circulatory system is in class 5, semester 1, theme 4, sub-theme 3. The following are the results of analysing the material used in media development.

Table 3. Material analysis

Themes	Sub Themes	Basic Competencies
Theme 4: Health is important	Sub-theme 3: Blood Circulatory Organs and Their Functions	KD 3.4. Explain the circulatory organs and their functions in animals and humans, as well as how to maintain the health of human circulatory organs

Design

After carrying out the analysis stage, the design stage is then carried out. At this stage, the design of learning media for the human circulatory system (PAPEDA) is done by making a media prototype. The following is the design of the PAPEDA media prototype that was developed.

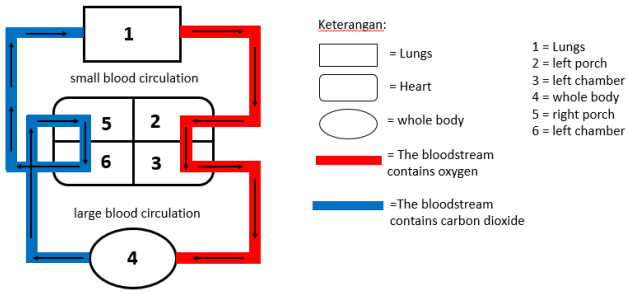

Figure 1. PAPEDA Media Prototype Design

Next, the design is carried out using Photoshop by selecting the required images, such as images of the lungs, heart and human body. The prints are then assembled based on the prototype that has been designed. The following is an image of the results of the human blood circulation board (PAPEDA) media design using Photoshop.

Then, after designing the product, the tools and materials that will be used to develop the media are selected. The materials used are 1) plywood boards; 2) outdoor vinyl sticker paper; 3) white paint as a base; 4) ¼ inch spirit level hose; 5) pump/spray bottle; 6) glue gun; 7) food colouring.

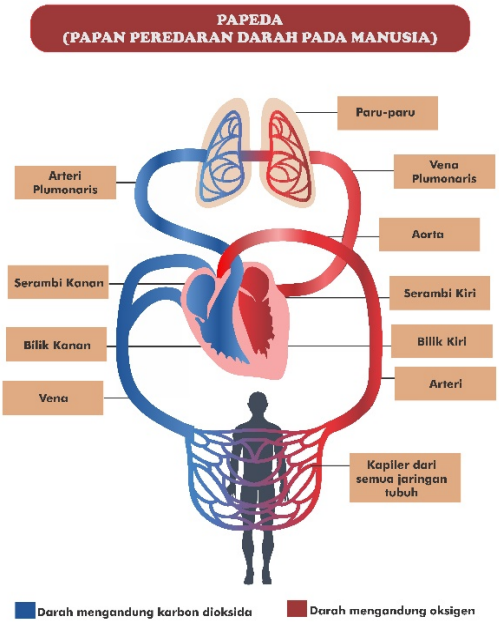

Figure 2. PAPEDA Media Product Design

Development

The next stage is the development stage. The result of this stage is draft 1 of the Human Blood Circulation Board Learning Media (PAPEDA). For more details, the image of the human circulatory board media (PAPEDA) that was developed can be seen in the following image:

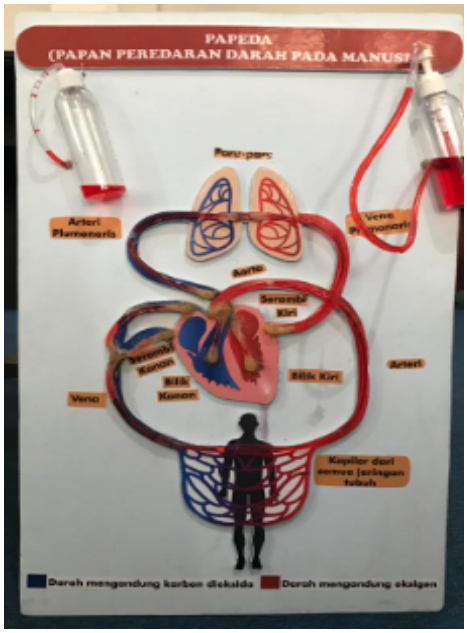

Figure 3. PAPEDA Media Draft 1

After obtaining draft 1 media, draft 1 media is assessed by two expert lecturers. This stage is carried out before field trials by handing over the development product to experts to provide assessment and advice regarding the validity of the development product. This validation of the development product aims to determine whether the PAPEDA media development product is suitable for learning science content in class 5. Apart from that, the validation carried out by two expert lecturers also aims to obtain suggestions and input on the developed product so that the PAPEDA media product is better.

Initial product developments that expert lecturers have assessed are analyzed to determine the validity and feasibility of the product. The assessment results from two expert lecturers stated that PAPEDA media was suitable and ready for research. The results of the recapitulation of expert lecturers' reviews of the validity of PAPEDA media are presented in the following table.

Table 3. Recapitulation of Media Validity Assessment

Aspect	Score		Average
	Validator 1	Validator 2	
Material	16	16	16
Media illustration	15	18	16.5
Media quality and appearance	23	27	25
Attractiveness	23	22	22.5
Total	77	83	80
Percentage	81%	87%	84%
Category			Very valid

Based on the Table 3, the average total assessment score from the two expert lecturers is 80 out of a maximum score of 95 or 84%, with the qualitative classification being very valid. Therefore, the quality of the development product in the form of human blood circulation board media (PAPEDA) oriented towards students' mastery of scientific concepts was declared suitable for trials after revisions. The following are the results of media revisions after validation.

The figure 4 is PAPEDA media after being given input by the validator before testing. The press in draft 2 shows an arrow indicating that the blood flow is small and the blood flow is significant so that the direction of blood flow is straightforward and does not confuse students.

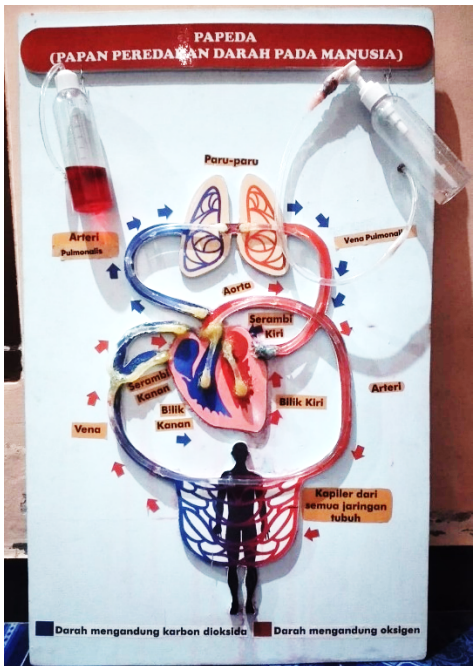

Figure 4. PAPEDA media after revision (Draft 2)

Implementation

After carrying out the analysis, design and development stages, PAPEDA media products were then tested. The trial was carried out in 2 meetings. The first meeting was used to provide a pretest on the ability to master science concepts; the next meeting was used to try out the learning media developed in the form of PAPEDA media on science content in class 5 with material on the human circulatory system. After testing the generated media, a posttest was conducted to see students' ability to understand science concepts after using PAPEDA media.

25 grade 5 students at SD Negeri 14 Cakranegara carried out the product trial. This implementation stage was carried out on September 15 and 16, 2023. The results of the implementation stage were data from pretest and posttest results on the ability to master science concepts and the results of teacher and student assessments of the PAPEDA media products being developed.

Based on the figure 5, it can be seen that the average posttest results are higher than the average pretest results. This means students' mastery of science concepts increases after learning science using the developed PAPEDA media. Next, a description was carried out based on the number of classics students completed after learning PAPEDA media to see the effectiveness of the product being developed. The following is the classical percentage of students' ability to master science concepts.

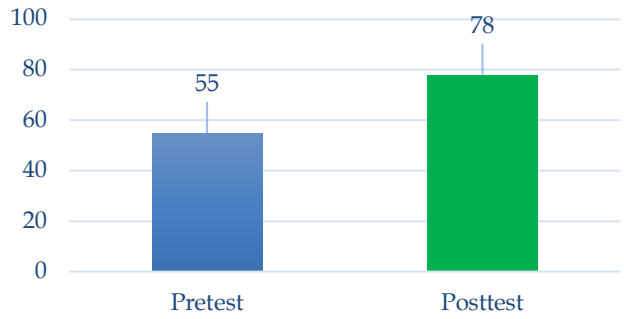

Figure 5. Graph of Pretest Posttest Results for Mastery of Science Concepts

Table 4. Percentage of Students' Classical Completion

	Pretest		Posttest	
	Frequency	Percentage (%)	frequency	Percentage (%)
Complete	7	28	20	80
Incomplete	18	72	5	20

Based on the effectiveness criteria in this research, the media developed is effective if it meets the requirements for classical completeness in the science concept mastery test at a minimum percentage in the 61% to 80% range. Meanwhile, the results shown in the table above show that the rate of classical completion after using PAPEDA learning media is 80%, which means that the PAPEDA media products developed are effective in terms of students' mastery of science concepts.

At this stage, practicality data was also obtained to assess teacher and student responses to PAPEDA media products used for learning. The following are the results of the teacher and student questionnaire assessments.

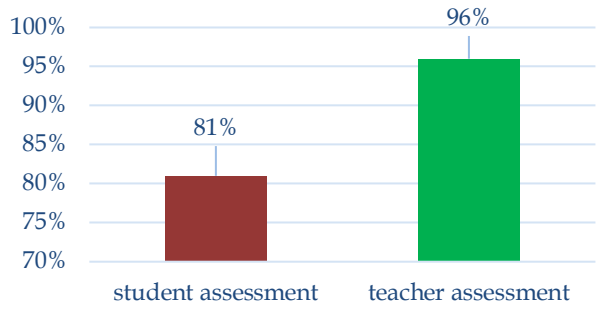

Figure 6. Teacher and Student Assessment Results

The graphic on figure 6 results from teacher and student assessment of the human blood circulation board (PAPEDA) learning media product. These results show that the teacher assessment questionnaire obtained an average of 96% in the convenient category, and the student assessment questionnaire received an average of 81% in the very practical category. This shows that PAPEDA learning media is practical to use.

Discussion

This study was used to see the final results of the product developed, namely human circulatory system learning media (PAPEDA), oriented towards students' mastery of science concepts. The development of this learning media went through 5 stages. This is by the stages of the ADDIE model, namely analyze, design, develop, implement and evaluate. The final product is expected to meet the criteria of being valid, practical and effective. Nieveen, (1999) statement states that quality development must meet 3 criteria: validity, practicality and effectiveness. The results of validation and field trials concluded that the PAPEDA learning media developed fulfilled these three aspects, namely valid, practical and effective in terms of students' mastery of science concepts. The study of the quality of the final product based on these three aspects is described as follows.

Validity of PAPEDA Learning Media

The validity of learning media is obtained from the results of expert assessments. Based on the evaluation of 2 experts, the qualitative classification results were excellent and declared suitable for use with revisions based on suggestions from validators on PAPEDA media. Therefore, learning media is declared valid because it meets the established criteria. Then the learning media product is also developed based on relevant supporting theories. In line with what Nieveen, (1999) said, a development product is declared valid if the product is developed based on a solid theoretical rationale and internal consistency between the components in the development product.

Practicality of PAPEDA Learning Media

The practical aspect of learning media is used to determine the ease of use of the press developed in learning, both for teachers and students. Assessment of the practicality of development products based on teacher assessments of PAPEDA learning media is oriented towards mastery of science concepts. After the field trial, the results of the teacher's evaluation of the learning media developed qualitatively at intervals with excellent and reasonable criteria. This shows that the learning media developed can be easily applied by teachers in learning. Then the practical aspect measured from student assessments is qualitatively in a reasonable

interval. This shows that the learning media developed can be used by students easily. Based on the teacher's assessment results, it can be concluded that the PAPEDA learning media developed meets practical criteria.

Effectiveness of PAPEDA Learning Media

The effectiveness of PAPEDA learning media is obtained from the results of tests on students' mastery of science concepts. From the results of field trials, PAPEDA media has met the effective criteria. The results of the science concept mastery test after learning using the PAPEDA learning media showed that the students' classical completion results were 83% or 25 students out of 30 students. This indicates that the PAPEDA learning media developed is effective.

PAPEDA learning media is effective because the learning process involves student activities that can support students' mastery of science concepts. In this lesson, students are allowed to try and observe the media directly so they understand the blood flow pathways in humans. This is in line with what theory that learning by involving students will enable them to discover a concept so that students can develop their abilities through guidance from the teacher (Rachmah, 2012; Hariri et al., 2020; Hanid et al., 2020). On the other hand, Brown & McNamara, (2011) say that interactive media, such as simulations or learning applications, can be an effective tool in increasing understanding of complex concepts.

PAPEDA learning media developed after conducting trials can increase effectiveness. This aligns with what Nurfadhillah et al., (2021) said: by using visual media in teaching science, teachers can improve learning effectiveness, strengthen understanding of science concepts, and motivate students to be more interested in the subject. Then Sulastri, (2022) said that visual media can help students relate scientific concepts to situations or objects in the real world. Learning media can improve the quality of learning and make it easier for students to understand lesson material. Therefore, using learning media is highly recommended in teaching and learning (Supardi, 2017; Firdaniati et al., 2022; Sulastri, 2022; Astuti & Budianti, 2014).

Conclusion

Based on the research and discussion results, it was concluded that the PAPEDA learning media was oriented towards mastering students' science concepts and had met the valid criteria for the science lesson content on the human circulatory system based on the assessment of two expert lecturers. This can be seen based on the average PAPEDA learning media assessment score of 84%, with a very valid category. Furthermore, in practicality, the PAPEDA learning media developed has met practical criteria based on teacher and student assessments. This can be seen based on the total scores of teacher assessments and student assessments of learning tools, respectively, 96% in the convenient category and 81% in the suitable category. Then, regarding the effectiveness aspect of the learning media, it has met the criteria for effectiveness in the material on the human circulatory system in grade 5 elementary school regarding students' mastery of science concepts. This is shown based on the science concept mastery test results, which reached the KKM in the posttest results of 80% or 20 students out of 25 students. Therefore, the PAPEDA learning media developed is suitable for use because it meets the valid, practical and effective criteria.

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Author Contributions

In this research, all authors contributed according to their respective assignments. The first author and the fifth author contributed to completing this research. Asri Fauzi, Ida Ermiana and Aisa Nikmah Rahmatih contributed to designing research, developing media, conducting research, collecting data, and writing articles. Then Ilham Handika and Awal Nur Kholifatur Rosyidah contributed to correcting test results, inputting data, analyzing data, and contributing to completing the reports that had been prepared.

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Conflicts of Interest

The authors declare that there were no conflicts of interest in the writing of this article.

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