

Development of Song-Assisted Virtual Reality-Based BioPulse Learning Media to Improve Learning Outcomes of Human Circulatory System Materials

Fahrizal Husni Maulana*, Putri Yanuarita Sutikno

Elementary School Teacher Education Study Program, Faculty of Education and Psychology, Semarang State University, Semarang, Indonesia

*e-mail: mfahrizal861@students.unnes.ac.id

Received: February 27, 2026. Accepted: March 30, 2026. Published: April 21, 2026

Abstract: The low understanding of students of abstract science subjects, especially the human circulatory system, is due to the fact that the learning process is still dominated by lecture methods and the use of textbooks, so that students are less actively involved. This study aims to develop and test the effectiveness of song-assisted virtual reality-based BioPulse learning media in improving the learning outcomes of grade V students on the human circulatory system material. This research uses the ADDIE development model, which includes the stages of analysis, design, development, implementation, and evaluation. The subject of this study is grade V students at SD Negeri Mulyosari, totalling 31 students. The trial was carried out in two stages, namely a small-scale test involving 9 students and a large-scale test involving 22 students. Data collection was carried out through validation by media experts and experts in learning outcome test materials, in the form of pretests and posttests, as well as questionnaires on teacher and student responses to BioPulse learning media. Data analysis was carried out using normality tests, paired-samples t-tests, and N-Gain tests. The results of the study showed that the BioPulse media developed obtained validation scores of 93.3% for media experts and 91.6% for material experts, indicating a very feasible category. The average student pretest score of 45.4 increased to 87.9 in the posttest. The results of the paired-samples t-test showed a significance value of 0.000 (< 0.05), indicating a significant difference between the values before and after media use. The N-gain is 0.79, which is in the high category. Teachers' and students' responses to the media are in the very decent category. The song-assisted, virtual reality-based BioPulse learning media was found to be valid and effective in improving student learning outcomes in human circulatory system material in elementary schools.

Keywords: Elementary School; Learning Media; Learning Outcomes; Educational Songs; Virtual Reality.

Introduction

Education in the era of the Industrial Revolution 4.0 demands fundamental changes in the approach to learning, especially at the elementary school level. The presence of digital technology today has become an important element in the educational process, and innovation in learning media is an important element in increasing student participation and learning outcomes [1]. One of the technologies that has received great attention is virtual reality (VR), which is able to present an immersive and interactive learning experience [2]. The application of VR in education can strengthen the understanding of abstract concepts through three-dimensional visualization and real-world simulations that are difficult to obtain with conventional learning methods [3].

In science learning in elementary school, especially in abstract material on the human circulatory system, students often have difficulty understanding biological processes that cannot be observed directly. Learning media innovations are needed that are able to present concrete visualizations and fun learning experiences. One of these innovations is the development of BioPulse learning media, a virtual reality-based, interactive learning resource designed to help grade V students understand the concept of the circulatory system in a more in-depth and meaningful way.

BioPulse learning media is a virtual reality technology-based media innovation that integrates the

visualization of the human circulatory system in the form of a three-dimensional environment, with audio support in the form of educational songs [4]. BioPulse is an acronym for pulse biology, reflecting the concept of dynamic, rhythmic, and continuous learning in living systems. BioPulse media not only serve as a medium for visualizing abstract concepts, but also a means to improve students' cognition.

In Indonesia, the MilleaLab platform has emerged as one of the most widely used alternatives for developing VR-based learning media, thanks to its ease of use in creating virtual learning environments without advanced programming knowledge. The use of MilleaLab in education can support students' learning outcomes, enthusiasm, and interest in subject matter [5]. The implementation of VR at the elementary school level still faces several obstacles, including limited infrastructure, teacher readiness, and the need for media design aligned with elementary school children's cognitive development.

In addition to the technological aspect, the integration of art and cultural elements in learning can also increase students' emotional engagement [6]. Educational songs have an important role in helping students remember and understand learning concepts in a more fun and meaningful way [7]. The development of song-assisted virtual reality-based BioPulse media is a relevant innovation because it combines an immersive technology approach with a song approach to strengthen students' memory.

How to Quote:

F. H. Maulana and P. Y. Sutikno, "Development of Song-Assisted Virtual Reality-Based BioPulse Learning Media to Improve Learning Outcomes of Human Circulatory System Materials", *J. Pijar.MIPA*, vol. 21, no. 2, pp. 376–384, Apr. 2026. <https://doi.org/10.29303/jpm.v21i2.11771>

The main problem behind this study is the low level of involvement and learning outcomes of grade V students in understanding abstract science material. Circulatory material contains abstract concepts that are difficult for students to understand when explained only in conventional media. Without concrete visualization, the learning process tends to make students less able to relate the material to real life. As a result, understanding of concepts is limited and learning outcomes do not reach optimal levels. Many students have difficulty understanding concepts that cannot be directly observed, such as the working processes of organs or system mechanisms in the human body, especially when learning is still dominated by lecture methods and the use of conventional textbooks [8]. This condition tends to make students passive, less motivated, and to make it difficult for them to relate the material to their real experiences.

The characteristics of elementary school students who are at the concrete operational stage require learning media that are able to present real, interesting, and easy-to-understand visualizations. The use of technology in science learning remains suboptimal, often limited to static media that are less effective at dynamically and interactively describing scientific processes. This less varied learning has an impact on students' low interest, concentration, and retention of the material learned [9].

This condition shows the need to develop learning media that are multisensory, interactive, and contextual, thereby creating a more immersive and meaningful learning experience. Given the existence of media innovations aligned with the characteristics of student development, it is hoped that the active involvement and learning outcomes of grade V students in science subjects will increase significantly.

Various previous studies have explored the effectiveness of the use of VR in education, such as the use of VR-based MilleaLab to improve the cognitive skills of junior high school students in understanding biology materials, as well as the application of VR in learning Pancasila to strengthen the understanding of cultural values [10]. Research that specifically combines VR with musical elements into a single integrated learning medium for elementary school students remains very limited. BioPulse is designed not only to improve understanding of concepts, but also to foster learning motivation, active engagement, and enjoyable learning experiences [11].

Theoretically, this research is expected to enrich studies in educational technology, especially the development of virtual reality-based learning media integrated with musical elements. In practice, the results of this research are expected to help teachers create more interactive and innovative science learning, as well as serve as a reference for learning media developers in designing VR-based educational products that suit the characteristics of elementary school students.

Several previous studies have examined the use of virtual reality in social studies learning to improve understanding of abstract concepts. Most of the research only focuses on visualizing concepts through immersive technology without integrating musical elements as a reinforcement of students' learning memory. The integration of virtual reality and educational songs into a single learning medium is still rarely developed, especially in elementary

school science instruction. This research develops a song-assisted virtual reality-based BioPulse learning media as a learning innovation that combines immersive visualization and reinforcement to improve student learning outcomes on human circulatory system materials.

This study aims to develop and test the effectiveness of song-assisted, virtual reality-based BioPulse learning media in improving the learning outcomes of grade V students. Through a Research and Development (R&D) approach, this research seeks to develop valid, practical, and effective learning media products that support meaningful learning in the digital era.

Research Methods

This research uses the Research and Development method with the ADDIE development model, which comprises five stages: Analysis, Design, Development, Implementation, and Evaluation. The research design used at the implementation stage is a one-group pretest and posttest, which is a design that is carried out twice, before and after treatment, to determine changes in student learning outcomes [12].

The ADDIE model was chosen because it has a systematic and structured step in developing valid, practical, and effective learning products [13]. This model is highly relevant for developing technology-based learning media, especially song-assisted, virtual reality-based BioPulse media designed to improve the learning outcomes of grade V students in the human circulatory system material.

The first stage is analysis. At this stage, the identification of learning needs in grade V of elementary school is conducted, particularly regarding students' difficulties in understanding abstract concepts of the human circulatory system. The analysis was carried out through observation of the learning process and interviews with classroom teachers [14].

The second stage is design planning. At this stage, the design of BioPulse's virtual reality-based learning media, featuring songs, is planned. The design includes the preparation of storyboards and media navigation flows, the design of the visual appearance of the circulatory organs in the form of a three-dimensional virtual environment, as well as the preparation of lyrics and song arrangements that are tailored to the learning material [15]. At this stage, learning tools were also prepared in the form of a Deep Learning Implementation Plan (RPPM) using a deep learning approach, along with research instruments such as expert validation sheets, pre-test questions, post-tests, and student response questionnaires.

The third stage is development. At this stage, the design that has been designed is realized into a real product using the MilleaLab platform as a development medium Virtual Reality. The media is developed by integrating 3D visualization, material narratives, interactive elements, and educational songs as concept reinforcements. The finished product is then validated by material experts and media experts to assess the feasibility aspects of content, display, interactivity, and language suitability with the characteristics of elementary school students [16]. The validation results are analyzed using the Likert scale and used as a basis for revision until the product is declared suitable for testing. The criteria are in Table 1.

Table 1. Media Eligibility Criteria

Percentage	Categories
81% - 100%	Highly Worth It
61% - 80%	Worthy
41% - 60%	Quite Decent
21% - 40%	Less Worthy
0% - 20%	Very Unworthy

[17]

The fourth stage is implementation. The revised media was then tested with grade V students of SD Negeri Mulyosari during learning activities, in accordance with the prepared RPPM. At this stage, students use virtual reality-based BioPulse media, assisted by songs, in the learning process. Data collection was carried out through the provision of pre-tests to assess students' initial abilities, post-tests to evaluate learning outcomes after using the media, and student response questionnaires to assess the practicality and attractiveness of the developed media.

Table 2. Media Response Criteria

Percentage	Categories
81% - 100%	Highly Worth It
61% - 80%	Worthy
41% - 60%	Quite Decent
21% - 40%	Less Worthy
0% - 20%	Very Unworthy

[18]

The last stage is evaluation. The evaluation was carried out to determine the effectiveness of the media in improving student learning outcomes. The data on the results of the pre-test and post-test were analyzed to see the improvement of students' abilities, one of which was through the calculation of the N-Gain score [19].

This research was conducted at SD N Mulyosari, located in Boyolali District, Boyolali Regency, Central Java, with 5th-grade students as the research subjects. The subjects studied included all grade V students at SD N Mulyosari, totalling 31. The small-scale test stage involves 9 students, while the large-scale test involves 22 students. Given that the population is relatively small and consists of only one class, the sampling method used is *total sampling*. This method was chosen to reduce the risk of sampling errors and to gain a clearer understanding of the effectiveness of the media that has been developed.

Data analysis was carried out qualitatively and quantitatively. The results of the pretest and posttest were analyzed using normality tests, paired sample t-tests and N-Gain tests to determine the significance of improving learning outcomes.

Table 3. N-Gain Value Criteria

N-Gain Value	Criteria
$g \geq 0.70$	Height
$0.30 \leq g < 0.70$	Medium
$g < 0.30$	Low

[20]

The classification results, as listed in Table 1, serve as a benchmark for assessing the effectiveness of the learning media developed in improving student learning outcomes.

Results and Discussion

This research was conducted at SD N Mulyosari, located in Boyolali District, Boyolali Regency. The subjects in this study amounted to 31 students. The research entitled "Development of Song-Assisted Virtual Reality-Based BioPulse Learning Media to Improve the Learning Outcomes of Human Circulatory System Materials" uses the ADDIE development model, namely analysis, design, development, implementation, and evaluation (evaluation). During this stage, the researcher developed a virtual reality-based BioPulse learning media, supported by songs, as an innovation to make the learning process more interesting and interactive for students. The following describes the steps researchers took in developing song-assisted, virtual reality-based BioPulse media products.

Analysis Stage

Media development begins with a needs analysis stage, carried out through classroom observation of the learning process. At this stage, it was found that grade V students at SD Negeri Mulyosari had difficulty understanding the material on the circulatory system due to its abstract nature and its inability to be directly observed. The learning process is still dominated by lecture-based instruction and textbook use, leading students to be passive and less engaged. The lack of technology-based learning media that is able to display a concrete and interactive visualization of the circulatory process is also one of the factors that cause low student learning outcomes.

The findings show a discrepancy between the characteristics of elementary school students in the concrete operational stage and the learning methods that remain verbal and abstract. Learning media is needed that can provide a more visual, interactive, and contextual learning experience, helping students better understand the human circulatory system.

Based on the analysis, the development of innovative and engaging learning media is needed to enhance the learning process. One alternative is the virtual reality-based BioPulse learning media, assisted by songs, which can present a more realistic and interactive visualization of the human circulatory system. By integrating virtual reality technology into learning songs, it is hoped that students will have a more engaging learning experience, increase their involvement in learning, and better understand concepts of the circulatory system.

Design Stage

At the planning stage, the media are developed based on the results of the previously carried out needs analysis. At this stage, it was found that the presentation of circulatory system material needed to be packaged as a systematic visual flow to make it easier for students to understand. Abstract material requires a concrete presentation through structured visualization so that students can clearly understand the blood process [21]. The integration of songs into learning media is needed to strengthen students' memory of the concepts they learn.

The media design process begins with preparing a Deep Learning Implementation Plan (RPPM) as the basis for

determining learning objectives, materials, and steps for learning activities. Next, a storyboard was prepared that contained the flow of material delivery in stages. This storyboard serves as a guide in displaying the visualization of the organs involved in the human circulatory system. With this navigation, students can learn the material gradually, making it easier to understand the relationships between organs in the human circulatory system.

The media design is also prepared with consideration of visual appearance, ease of use, and suitability for elementary school students. The visual display is designed to be attractive and communicative, while the navigation is kept simple to make it easy for students to use. This design is tailored to students' needs, ensuring that learning is not only visually appealing but also easy to use and understand.

The findings at this stage indicate that the design of learning media should balance technological and pedagogical aspects. The designed media not only serves as a visual aid but also supports an effective learning process. Thus, a learning media design that attends to these two aspects is expected to help students understand the material on the human circulatory system.

Development Stage

The development stage is the process of realizing a media design that has been made into a real product to achieve learning goals. The product developed in this study is a virtual reality-based BioPulse learning media, enhanced by the integration of educational songs to help deepen understanding of concepts. This immersive media is specifically designed to meet the characteristics and needs of grade V elementary school students in science subjects, especially to concretize abstract material on the human circulatory system. By combining three-dimensional visual technology with musical elements, this media is expected to increase active involvement and student learning outcomes. Here are the results of the development of the song-assisted BioPulse media.

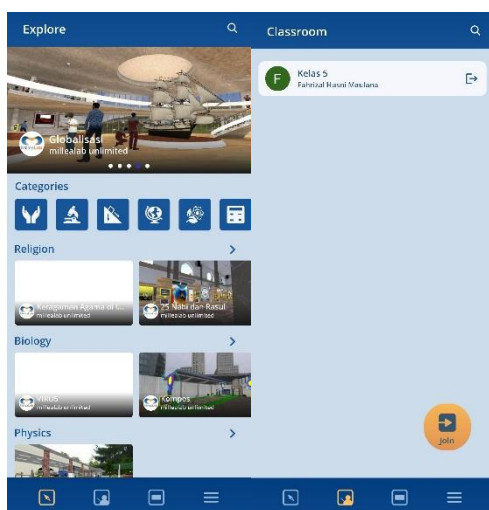


Figure 1. Explore Menu & Classroom Menu

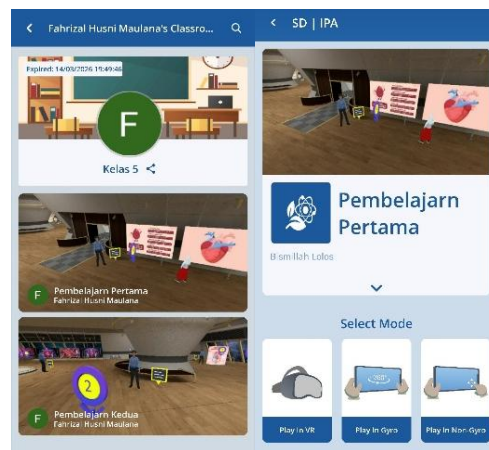


Figure 2. Classroom Menu View

This section is the starting page for students to interact with the media. The main menu display provides intuitive navigation, including a start button, instructions, and developer information. The instruction feature is specifically designed to make it easier for grade V students to understand the navigation controls in the virtual space, ensuring a smooth learning process.

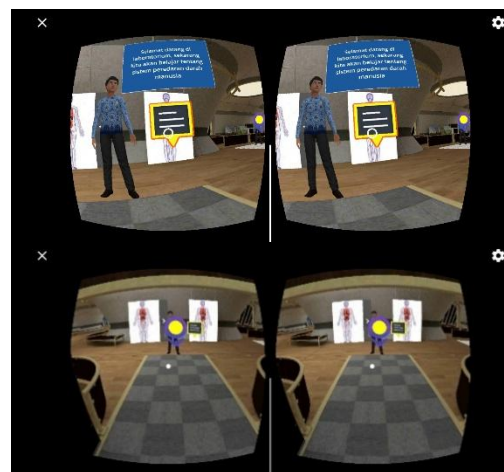
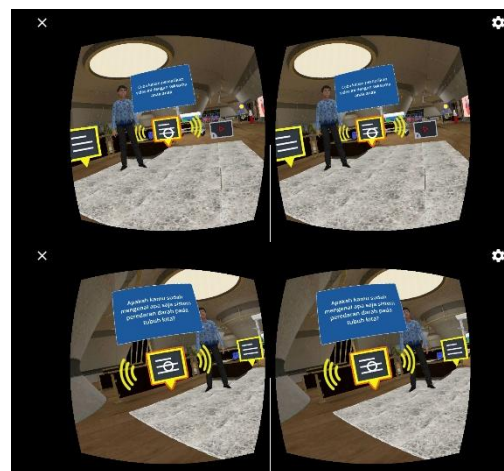


Figure 3. First-Class Initial Display



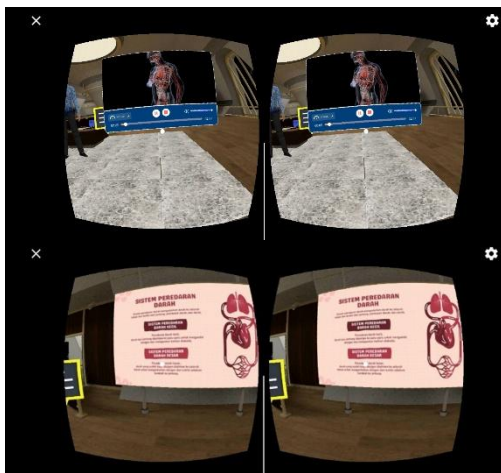


Figure 4. Video & PowerPoint Material Display



Figure 5. Educational Song Video Display

When they first entered the virtual classroom in this laboratory, students were immediately directed to explore the human circulatory system in depth. The main focus of this digital environment is to guide students in understanding the mechanisms of the heart and blood circulation through interactive visual media (Figure 4).

In the next view, with instructions displayed on the screen, students are invited to actively dissect the components of the circulatory system presented in the virtual laboratory to gain a more comprehensive understanding of biology, with explanations in video and PowerPoint slide formats. Not only watching and listening, but students are also invited to sing songs about the circulatory system presented in Figure 5.

The integration of educational songs that contain lyrics in this virtual environment serves as a cognitive bridge to help students memorize the sequences of large and small blood circulation more easily and enjoyably. Through a combination of virtual reality environment visualization and songs, students can have a more interactive and meaningful learning experience. The tune used in BioPulse's learning media is adapted from the song "Kampung Nan Jauh, di Mato," composed by Oslan Husein, from West Sumatra. The choice of notes is based on the melody that is easy to remember and familiar, making it easier for students to memorize the material conveyed through the song lyrics. The lyrics of the songs used in the learning media are as follows:

*Peredaran darah manusia
Adalah tertutup
Alat peredaran darah manusia
Jantung dan pembuluh darah*

*Darah kotor dari tubuh
Lewat bagian vena*

*Masuk ke srambi kanan, terus
Ke bagian bilik kanan*

*Masuk organ paru-paru
Itu adalah darah bersih
Kembali menuju ke jantung lagi
Lewat pembuluh arteri*



Figure 6. Second-Class Display

Entering the second lesson, students are presented with an immersive learning experience that begins with visualization of the heart and exposure to the material through interactive images and educational song videos.

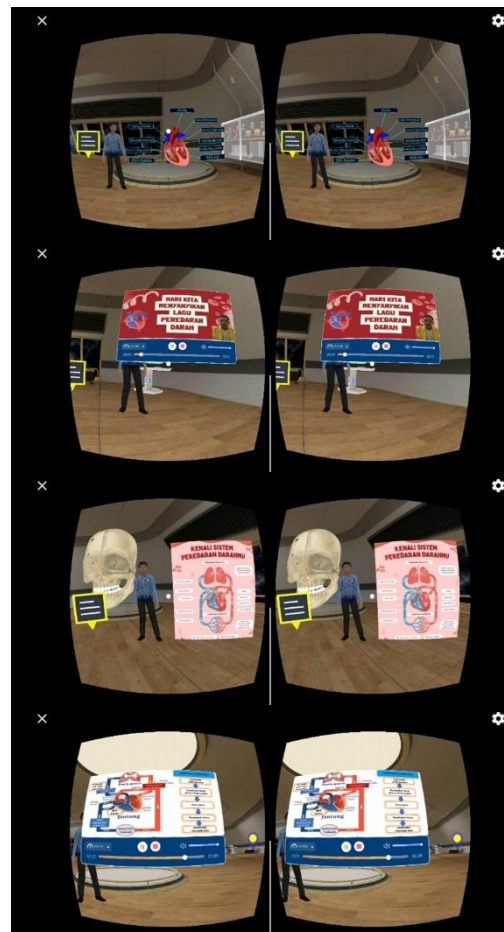


Figure 7. Second Learning Material Display

On this page, students recognize anatomical elements in detail, presented with a 360° visualization of the heart, as well as the presentation of the material with interesting images. Furthermore, the material is deepened through educational videos that systematically explain the flow of large and small blood circulation by interacting through the song of the human circulatory system to facilitate the process of memorizing the material in a fun way.

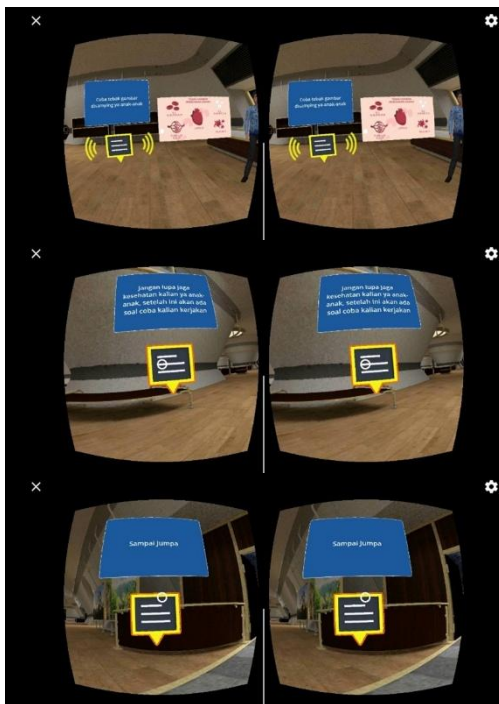


Figure 8. Guess the Picture & Quiz Display

At the end of the learning session, students were given interactive quizzes and guessing pictures of the human circulatory system. This feature measures students' understanding of the material studied.

After the BioPulse-based learning media and Virtual Reality, the next step is to validate it with media and material experts. This validation aims to assess the feasibility of the learning media that have been developed, both in terms of their content, appearance, and use, before they are used in the learning process. The validation results for BioPulse learning media from media and material experts are shown in the following table.

Based on validation results from media and material experts, the BioPulse-based learning media, Virtual Reality Song Assisted, received an assessment in a suitable category for use in the learning process.

Table 4. Validation Table for Media Experts and Subject Matter Experts

Validation Type	Percentage	Categories
Media Validation	93.3%	Highly Worth It
Material Validation	91.6%	Highly Worth It

Implementation Stage

The learning activities in this study aim to test the media developed after the media and material validation test

stage. The research was carried out in two stages of trials in class V of SD N Mulyosari: small-scale and large-scale trials. The small-scale trial involved 9 students and the large-scale trial involved 22 students. Before being used in the research on test instruments, 40 questions were first administered to 26 grade VI students to determine their validity and feasibility. Based on the analysis, 20 questions were identified as suitable for use as research instruments in the form of multiple-choice items for pretest and posttest activities.

The implementation of research in class V of SD N Mulyosari before the first learning began, students were given pretest questions consisting of 20 multiple-choice questions to find out the student's initial level of understanding of the material of the human circulatory system, followed by the learning process using virtual reality-based BioPulse media through the MilleaLab application combined with the help of songs as a learning support medium. Through these media, students can explore the material in a more interactive and immersive way.

In use, students take turns using virtual reality glasses in their groups to explore the material presented. Students can take a closer look at different parts of the human circulatory system by exploring the available virtual environments. The navigation feature on the app allows students to move in different directions, such as right, left, front and back, by adjusting the direction of the head's view. As well as changing the angle of view by moving the head or body according to the object you want to observe.

Furthermore, a posttest was administered after the second learning session, consisting of 20 equal multiple-choice questions to measure students' understanding after using the song-assisted, virtual reality-based BioPulse media. After the posttest, the activity continued with the distribution of student response questionnaires to virtual reality-based BioPulse media. This questionnaire aims to gather students' responses on aspects of appearance, ease of use, clarity of the material, and their interest in using BioPulse media during the learning process. The results of the pretest and posttest are then analyzed to determine the effectiveness of the use of the developed learning media. Pretest and posttest data were analyzed using normality tests, paired sample t-tests, and N-Gain tests to determine students' level of understanding after using BioPulse media.

Table 5. Showing the results of the normality test on the pretest and posttest data. On a small scale, the pretest significance value was 0.481, and the posttest significance value was 0.407. Meanwhile, on a large scale, the pretest significance value was 0.97, and the posttest significance value was 0.197. All of these significance values are greater than the value of 0.005 (Sig. > 0.05), so that it can be concluded that the research data is normally distributed. This is in accordance with the normality test criteria, which state that if the p-value is greater than 0.05, the data are normally distributed [22]. Thus, both small- and large-scale posttest-pretest data are eligible for parametric statistical testing.

Table 6. The value obtained from the Sig. (2-tailed) The significance test is 0.000 less than 0.05, thus indicating that Hypothesis Ha is accepted and Hypothesis H0 is rejected. Furthermore, the results of the significance test on a large scale (Sig. 2-tailed) also showed a value of 0.000, which was smaller than 0.05. Thus, it can be concluded that there is a significant difference between pretest and posttest

scores in small groups and large groups after the application of BioPulse learning media. These results are consistent with the view that the paired t-test is used to determine the average difference between two paired data sets, such as before-and-after treatment values, and that decisions are based on a significance value of < 0.05 [23].

Table 5. Normality Test

	Statistic	Shapiro-Wilk	
		df	Sig.
Small-scale pretest	.930	9	.481
Small-scale posttest	.922	9	.407
Large-scale pretest	.925	22	.097
Large-scale posttest	.939	22	.191

Table 6. Uji Paired Sample T-Test

	red	t	df.	Sig. (2-tailed)
Pretest – Small-scale posttest	-37.778	-25.702	8	.000
Pretest – Large-scale posttest	-42.500	-49.725	21	.000

Table 7. N-Gain Test

	N	Red	Categories
Small-scale N-Gain	9	.75	Height
Large-scale N-Gain	22	.79	Height

Table 7. The results of the N-Gain calculation in the small-scale test obtained a score of 0.7579 based on the N-Gain criterion [20] It shows that the improvement in learning outcomes is in the high category between pretest and posttest scores. Furthermore, based on the results of the large-scale N-Gain test on the use of BioPulse-based media and virtual reality, with songs implemented through the MilleaLab application, a value of 0.7945 was obtained in the high category.

Table 8. Media Response Results

Description	Percentage	Categories
Small-Scale Students	88.7%	Highly Worth It
Large-scale students	90.3%	Highly Worth It
Small-scale teachers	91.6%	Highly Worth It
Large-scale teachers	98.3%	Highly Worth It

The questionnaire results showed strong responses from both teachers and students. The response rates were 91.6% for small-scale teachers and 98.3% for large-scale teachers, while students achieved 88.7% and 90.3%, respectively.

Evaluation Stage

The evaluation stage in this study provides a comprehensive overview of the effectiveness of the learning media developed. Based on the data obtained, the evaluation results showed a significant increase in students' learning outcomes after participating in the learning process using the media intervention. The in-depth comparison of pretest and posttest scores for media use consistently shows a positive trend, demonstrating the real influence of technology use in the classroom. This is supported by the acquisition of N-Gain values in the high category, indicating that knowledge transfer and material understanding occur optimally.

Improving student learning outcomes after using song-assisted virtual reality-based BioPulse media is in line with the cognitive theory of multimedia learning, which emphasizes that the integration of visual and audio elements can optimize students' cognitive processes in understanding learning materials [24].

The percentage increase in comprehension, as well as providing empirical evidence, shows that the initial problem, in the form of low understanding of human circulatory system material in students, can be effectively minimised through appropriate learning media innovation. Through the integration of BioPulse-based media and virtual reality, with the help of songs, students no longer only learn conventionally and abstractly, but also gain experience of concrete visualisation and auditory stimulation that strengthen memory retention. The use of songs as a supporting instrument to recall key concepts, combined with the immersive experience of Virtual Reality, has proven to be able to arouse enthusiasm, curiosity, and active involvement of students in exploring the material [25]. This aligns with Jean Piaget's theory of cognitive development, which holds that students build their own knowledge through direct experience and interaction with the learning environment, making concrete, active learning easier to understand.

The use of BioPulse media enables a more dynamic interaction between teachers and students in both face-to-face and online settings. The advantages of visualization in a virtual environment help students understand material that is difficult to observe directly in the real world, making the process of assimilating knowledge faster [26]. From the perspective of constructivism, this process suggests that students not only passively receive information, but actively construct understanding through meaningful learning experiences [27]. The application of this song-assisted VR-based BioPulse media not only increases the acquisition of cognitive scores, but also transforms learning methods to be more interactive, responsive, and fun for students [28].

The findings of this study are also supported by several previous studies that show that the use of virtual reality technology in learning can improve students' understanding of concepts and learning outcomes. Research conducted by [10] indicates that the use of Virtual Reality-based learning media in elementary school science instruction positively influences student learning outcomes by providing a more concrete, interactive visualisation of concepts. The study's results show that VR media helps students understand abstract science concepts, thereby significantly increasing student engagement and learning outcomes.

Research conducted by [29] shows that the use of Virtual Reality-based learning media can increase engagement and learning outcomes among elementary school students in science. VR technology allows students to have a more immersive learning experience so that previously elusive concepts can be visualized more realistically in a digital learning environment.

The results of this study further strengthen the previous finding that the use of virtual reality technology as a learning medium can create a more interactive learning experience, increase student motivation to learn, and improve learning outcomes in elementary schools. Theoretically, this also reinforces the constructivist view that

learning that involves hands-on experience, exploration, and active student involvement results in deeper, more meaningful understanding.

Conclusion

Based on research and development results, the virtual reality-based BioPulse learning media, assisted by songs, has proven feasible and effective for learning science materials on the human circulatory system in grade V of elementary school. The results of validation by media experts and material experts show that the media developed is in the very feasible category. Effectiveness testing using a paired-samples t-test showed a significant difference between students' pretest and posttest scores after using BioPulse learning media. In addition, the N-Gain calculation showed an increase in learning outcomes in the high category across both small- and large-scale tests. The results of this study show that integrating virtual reality technology into educational songs can be an alternative for Natural and Social Science learning in elementary schools. Further research can develop similar media on other science materials or test its effectiveness at different levels of education, so that the use of immersive technology in education can be more optimal. Responses from teachers and students also showed very positive assessments of the media's appearance, ease of use, and appeal. Song-assisted, virtual reality-based BioPulse media can be an innovative alternative that enhances student engagement and learning outcomes in elementary school science instruction.

Author's Contributions

F.H. Maulana: contributions include research conceptualization, media development, data collection, data analysis, and manuscript writing. P.Y. Sutikno: contributes to the research supervisor, validation of research concepts, supervision of the research process, and revision and improvement of article manuscripts.

Acknowledgments

The author expresses his appreciation and gratitude to the Elementary School Teacher Education Study Program, Faculty of Education and Psychology, Semarang State University, for the academic support provided during the implementation of this research. Special thanks to Dr. Putri Yanuarita Sutikno, S.Pd., M.Sn. as a supervisor who has provided, direction, and constructive input during the research process until the preparation of this article. The author also expressed his gratitude to the parents who always provided prayers, support, and motivation so that this research could be completed properly. The author expressed his appreciation to the principal, teachers, and students of SD Negeri Mulyosari for providing opportunities and assistance during the research implementation.

References

- [1] P. A. Saputra and P. Yanuarita, "The Relationship of Learning Facilities and Learning Motivation to Social Studies Learning Outcomes of Grade V Students," *Joyf. Learn. J.*, vol. 6, no. 1, pp. 37–44, 2017.
- [2] F. M. Fauzan, "The Effectiveness of Virtual Reality Media Assisted by Millealab on The Cognitive Abilities of Junior High School Students on The Concep," vol. 5, no. 59, pp. 54–60, 2024.
- [3] M. N. Huda and P. Y. Sutikno, "Development of Prezi-Based Learning Media Assisted by Virtual Reality and Songs on Solar System Science Material," *J. Pijar Mipa*, vol. 20, no. 3, pp. 474–481, 2025, doi: 10.29303/jpm.v20i3.8895.
- [4] 3 Muhammad Naufal Azmi, Hamsi Mansur, Agus Hadi Utama a, "The Potential of the Utilization of Virtual Reality as a Learning Media in the Digital Era," *JDPP J. Dimens. Educators. and Learning*, vol. 12, no. 1, 2024.
- [5] S. Khoirunisyah, E. Purwanti, and P. Yanuarita, "The Effectiveness of the Group Investigation Learning Model on Social Studies Learning Outcomes," *J. Kreat. J. Basic Education*, no. September, pp. 73–80, 2016.
- [6] P. Y. Sutikno, "The Digital Era? ' Culture-Based Music Arts Education as a Learning Innovation in Elementary Schools," *J. Kreat. J. Basic Education*, vol. 11, no. 1, pp. 39–49, 2020.
- [7] Y. S. Rahayu and P. Y. Sutikno, "Development of SIAIR Interactive Media Assisted with Songs to Improve Learning Outcomes on Water Cycle Material in Elementary School," *J. Pijar Mipa*, vol. 20, no. 4, pp. 669–680, 2025, doi: 10.29303/jpm.v20i4.9128.
- [8] I. Nur Jannah, "The Effectiveness of the Use of Multimedia in Science Learning in Elementary Schools," *J. Ilm. Sec. Basics*, vol. 4, no. 1, p. 54, 2020, doi: 10.23887/jisd.v4i1.24135.
- [9] M. Amalia, M. V. Pratama, N. A. Pratiwi, and A. Fujiarti, "The Influence of Interactive Media on Students' Learning Interest in Science Learning in Grade 4 Elementary School," *J. Educator Window.*, vol. 4, no. 01, pp. 39–47, 2024, doi: 10.57008/jjp.v4i01.689.
- [10] N. N. Aini, M. Azizah, R. S. Bekti, and M. A. Thohir, "The Effectiveness of the Use of Virtual Reality Learning Media on Student Learning Outcomes in Science Learning in Elementary Schools," *Caruban J. Ilm. Educator Science. Basics*, vol. 6, no. 2, p. 267, 2023, doi: 10.33603/caruban.v6i2.8611.
- [11] S. Syahirah, R. Riandi, and H. K. Surtikanti, "Literature Review: The Application of Virtual Reality Media to Increase Student Motivation and Learning Outcomes on Digestive System Material," *Biol. Teach. Learn.*, vol. 6, no. 2, pp. 109–117, 2024, doi: 10.35580/btl.v6i2.57113.
- [12] M. N. Nita Yuliantini, Budi Hendrawan, "The Effect of the Scaffolding Model on the Learning Outcomes of Grade IV Students of SDN Jayanugraha on Multiplication Materials," *QISTINA J. Indonesian Multidisciplinary.*, vol. 4, no. 1, pp. 799–806, 2025.
- [13] Andi Rustandi and Rismayanti, "The Application of the ADDIE Model in the Development of Learning Media at SMPN 22 Samarinda City," *J. Fasilkom*, vol. 11, no. 2, pp. 57–60, 2021, doi: 10.37859/jf.v11i2.2546.
- [14] A. Latip, "The Application of the ADDIE Model in the Development of Learning Tools," *J. Ilm. Educators. Science*, vol. 2, no. 1, pp. 45–55, 2022.
- [15] R. Ardianti, "http://ejournal.uikabogor.ac.id/index.php/TEK Vol. 11 No. 1, January 2022," vol. 11, no. 1, pp. 11–20, 2022.
- [16] K. Angie and N. Fatihah, "Development of Plickers-

- Based Interactive Media to Increase the Effectiveness of Fiqh Learning Evaluation," 2025.
- [17] M. N. N. S. Siswanto, Rizqi Ilyasa Aghni, "Development of Audio-Visual Based Learning Media for E-Learning Curriculum and Accounting Learning," *J. Educator. Accounting. Indonesian.*, vol. 19, no. 1, pp. 98–114, 2021.
- [18] I. D. Lestari, W. Novianti, and S. Dayanti, "Development of Formative Assessment in Biology Learning Based on the Quizizz Application in Class X Students of MAN 1 Sumbawa Indah," vol. 15, pp. 660–669, 2025.
- [19] A. A. Kurniawan, N. D. Rahmawati, and K. Dian, "The Influence of Canva Learning Media on the Learning Outcomes of Elementary School Students," *Univ. Pas.*, vol. 1, pp. 179–187, 2024.
- [20] M. A. Abdul Wahab, Junaedi, "The Effectiveness of Educational Statistics Learning Using the N-Gain Increase Test at PGMI," *J. BASICEDU*, vol. 5, no. 2, pp. 1039–1045, 2021.
- [21] A. Zulaika, Erlina, and Rachmat Sahputra, "Analysis of Virtual Reality-Based Learning Media Needs on Human Respiratory System Materials for Students with Hearing Disabilities Alan," *J. Educator. MIPA*, vol. 12, no. 1, pp. 1–7, 2022.
- [22] M. S. A. Latifah, M. Syamsul Ma'arif, "Development of Android-Based Arabic Learning Media with Interactive Learning Development Theory," *AL WASIL*, vol. 02, no. 1, 2024, doi: 10.30762/alwasil.v2i1.3540.
- [23] M. F. H. Diah Ayu Rahmani, Risnawati, "T-Student Test Two Paired Samples (Paired Sample t – Test)," *J. Researcher. Educator Science. Indonesian.*, vol. 4, pp. 568–576, 2025.
- [24] Naila Aryani & Agus Lestari, "Applying Multimedia Learning Theory to Improve Learning Quality," *J. MEDIA Akad.*, vol. 3, no. 12, 2025.
- [25] A. F. F. Diva Fikri Harry Adnan, Cepi Riyana, "Media Virtual Tour of Tembang Macapat Assisted by Millealab to Increase Students' Learning Motivation," *By J. Educator. Javanese Languages*, vol. 12, no. 2, pp. 125–140, 2024, doi: 10.15294/3027va57.
- [26] F. O. Raharjo, E. W. Winarni, and I. Koto, "The Influence of STEAM-Based Virtual Reality Media on SCIENCE Literacy in Science Learning in Elementary Schools," *J. KAPEDAS – Study. Educators. Basics*, vol. 2, no. 2, pp. 295–306, 2023, [Online]. Available: <https://ejournal.unib.ac.id/index.php/kapedas/index>
- [27] I. L. Sarry Sumiyaty, Ucu Rahayu, "A Systematic Overview: The Integration of Discovery Learning and Virtual Reality to Develop Critical Thinking in Science Learning in Elementary School," *Pendas J. Ilm. Educators. Basics*, vol. 32, no. 3, pp. 167–186, 2021.
- [28] S. Sutanto, S. I. Koto, and E. W. Winarni, "Development of Digital Teaching Materials Based on the Development of Digital Teaching Materials Based on Discovery Learning with Augmented Reality to Improve Critical Thinking Skills to Improve Critical Thinking Skills in Science Learning," *J. KAPEDAS – Study. Educators. Basics*, vol. 1, no. 2, pp. 175–187, 2022.
- [29] S. M. Widiyaningtyas Paraningrum, Koko Prasetyo, "The Application of Virtual Reality Media to Improve the Activity and Learning Outcomes of Science Students in Class VI of Gadingan State Elementary School 02 Mojolaban District, Sukoharjo Regency for the 2023/2024 Academic Year" vol. 09, no. September, 2024.