Jurnal Pijar MIPA
https://jurnalfkip.unram.ac.id/index.php/JPM

ISSN 1907-1744 (Print)
ISSN 2460-1500 (Online)

Development of Interactive Multimedia Based on Problem-Based Learning in the material on the Form of Substances and Their Changes to Improve Science learning Outcomes

Shindy Auliya*, Aldina Eka Andriani

Elementary School Teacher Education, Faculty of Education and Psychology, Semarang State University, Semarang, Indonesia
*e-mail: shindyauliya42@students.unnes.ac.id

Received: January 16, 2026. Accepted: February 23, 2026. Published: February 28, 2026

Abstract: The utilization of technology-based learning media by teachers has not been done optimally, resulting in low student learning outcomes, which is reflected in 64% of students who do not meet the Learning Objectives Achievement Criteria (KKTP). This study aims to describe the development design and to test the feasibility and effectiveness of an interactive multimedia program based on Problem-Based Learning to improve the learning outcomes of fourth-grade students at SDN Ngaliyan 03, Semarang City. This type of research is Research and Development (R&D) with the ADDIE development model. Twenty-eight fourth-graders from SDN Ngaliyan 03 in Semarang City served as the research subjects. Both tests (pretest and posttest) and non-test methods (observation, interviews, questionnaires, and documentation) were used to collect data. N-Gain, t-tests, and normality tests were used in data analysis. The results of the study showed that an interactive multimedia module on changes in the state of matter, developed using Problem-Based Learning syntax, was accompanied by the use of the PhET Colorado virtual laboratory as a learning stimulus through virtual experiments. Expert validation showed a feasibility level of 91.66% from material experts and 93.75% from media experts, with a very feasible category, reinforced by teacher responses of 92% and student responses of 95% which were also in the very feasible category. The effectiveness of the media is shown by an increase in pretest and posttest scores of 38.40, a t-test result of 0.000, and an N-Gain value of 0.6720, meeting moderate criteria. Based on this research, it can be concluded that an interactive multimedia Problem-Based Learning module on states of matter and their changes has been successfully developed, is highly feasible, and is effective in improving fourth-grade students' science learning outcomes at SDN Ngaliyan 03, Semarang City.

Keywords: Changes in the Form of Substances; Interactive Multimedia; Learning Outcomes; Problem-Based Learning.

Introduction

Natural Science (IPA) learning at the elementary school level is closely related to everyday life, which includes concrete materials as well as abstract concepts, such as the state of matter and its changes [1]. Ideal science learning should provide space for students to conduct direct observations, experiments, and exploration of natural phenomena in order to form a scientific understanding [2]. Natural Science in elementary schools consists of two main elements, namely the element of conceptual understanding, which requires the presentation of coherent, clear, and contextual material so that students are able to connect concepts with their daily experiences [3], and process skills, which are important basic abilities developed in science learning through practicums, projects, discoveries, and problem solving [3].

The scope of Natural Science (IPA) material in grade IV includes; 1) Living things and life processes that include humans, animals, plants, and their interactions with the environment, 2) Objects, materials, properties, and their uses that include solids, gases, and liquids, 3) energy and its changes that include force, sound, heat, magnetism, electricity, light, and simple machines [4]. IPA material that is abstract and difficult to observe directly requires appropriate learning media to visualize abstract concepts into concrete, easy-to-understand forms, and optimize the conceptual understanding and process skills of students. Learning media is a tool that can be used to support the smooth learning process, so that it takes place more effectively and optimally [5]. Ideal learning media is media that meets the learning needs of students [1], and motivates students to be more active. Technology-based learning media, for example, interactive multimedia, can meet the character and learning needs of students [6].

Based on pre-research data collected through observations, interviews, questionnaires, and documentation conducted with fourth-grade teachers and students at SDN Ngaliyan 03 in Semarang City, it was found that teachers' use of technology-based learning media was suboptimal. Teachers only use audio-visual media from YouTube that is not systematically organized, so the learning process is less than optimal. This results in a lack of interaction between teachers and students, and among students themselves, which makes the learning process less than optimal. The lack of variety in the media used by teachers makes students bored, uninterested, and lose concentration in the learning process. Technology-based learning media have great potential in increasing student motivation and involvement in the learning process [7].

How to Cite:
S. Auliya and A. E. Andriani, "Development of Interactive Multimedia Based on Problem-Based Learning in the material on the Form of Substances and Their Changes to Improve Science learning Outcomes", *J. Pijar.MIPA*, vol. 21, no. 1, pp. 185–192, Feb. 2026. https://doi.org/10.29303/jpm.v21i1.11496

In the learning activities, teachers have implemented the Problem-Based Learning (PBL) model, but it has not been optimally applied in the learning process in syntax 1 and syntax 2. The stimuli during problem orientation consisted solely of questions, with no variation. The lack of variation in stimuli led students not to be critical in connecting the problem-solving provided with the subjects to be studied [8]. In Syntax 2, the teacher divided the groups without using the results of the Cognitive Diagnostic Assessment; instead, they divided the groups into front and back seats. This non-homogeneous grouping prevented students from sharing knowledge with one another due to differences in cognitive abilities [8].

Students' learning outcomes on the material of substance and its changes were low. This is evidenced by 36% (10 out of 28) of students having met the KKTP and 64% (18 out of 28) not having met it, with a *KKTP* score of 70. Learning outcomes are the achievements obtained by students after participating in the learning process [9]. This condition indicates challenges in helping students understand matter and its changes. The learning process can be successful by using learning media that can increase learning motivation, thereby improving learning outcomes [10].

Students have difficulty understanding events related to changes in the form of substances in everyday life. Students experience confusion in distinguishing changes in substances that occur in everyday life, such as boiling water, water on the lid of a pot, iced tea left to melt, and water droplets outside the container. Students are not yet able to visualize the microscopic concepts underlying the process of substance change, so the learning process feels meaningless and difficult to understand logically. Conducting simple, practical experiments during the learning process can reduce misconceptions [11].

Based on the explanations of these problems, efforts are needed to improve learning quality through technology-based learning media, namely, interactive multimedia based on Problem-Based Learning. Interactive multimedia is a form of media that combines various elements such as text, images, audio, video, and animation, which are used to create attractive and effective learning for students [12]. Interactive multimedia can be used individually or in groups, and can be used anywhere and anytime [13]. The benefits of interactive multimedia include solutions for students with different learning styles, and it can be used for independent learning. Interactive multimedia improves student learning outcomes through a variety of learning media [13].

An ideal interactive multimedia piece contains four main functions. The four main functions are attention, affective, cognitive, and compensation [14]. Attention function in interactive multimedia is evident through the role of audiovisual media as an important element in attracting and focusing students' attention. The affective function in interactive multimedia is evident through the role of visual media in evoking feelings of pleasure, interest, and curiosity in learners when participating in learning activities or reading materials accompanied by images. Cognitive function in interactive multimedia is evident in the role of visual media in helping students understand and remember information, thereby supporting the achievement of learning objectives. The compensatory function in interactive multimedia is seen in visual media in helping students understand text, organize information, and remember material.

Interactive multimedia is integrated with the Problem-Based Learning model. The Problem-Based Learning model is a learning model that places students as the main subject by presenting real contextual problems to be analyzed and solved critically and systematically [15]. This model plays a role in developing critical thinking skills, creativity, and problem-solving skills related to everyday life [16]. Researchers will develop interactive multimedia based on Problem-Based Learning using the S.id microsite, and the Canva application will be used to create designs. The designs used are in accordance with the material that will be discussed in the interactive multimedia, based on Problem-Based Learning, and equipped with a virtual laboratory (Colorado).

Relevant research on interactive multimedia based on Problem-Based Learning concludes that the interactive multimedia developed is valid, highly feasible, and effective [17]. Another study discussing interactive multimedia based on Problem-Based Learning in science subjects concludes that interactive multimedia based on Problem-Based Learning using Canva is successful, highly feasible, and effective in improving student learning outcomes [4].

Based on the explanation of the problem, the researcher developed interactive multimedia on the material of the state of matter and its changes by utilizing the S. Id microsite, which integrates the Problem-Based Learning model. This media development includes designing learning videos, utilizing the PhET Colorado virtual laboratory, and providing interactive quizzes through Educaplay. To improve fourth-grade students' learning outcomes at SDN Ngaliyan 03, Semarang City, regarding the state of matter and its changes, researchers will develop interactive multimedia based on problem-based learning. The development of interactive multimedia based on problem-based learning aims to describe its design and to assess its feasibility and effectiveness.

Research Methods

This type of research is Research & Development using the ADDIE development model which consists of 5 stages, namely; Analysis covering problems, potential, and needs, Design includes initial product development design (prototype), Development includes developing the final product, and conducting product feasibility tests with material experts and media experts, Implementation includes the application of small group and large group products, and Evaluation by evaluating the results of the product effectiveness analysis. [18]. Twenty-eight fourth-grade students from SDN Ngaliyan 03, 14 boys and 14 girls, were the subjects of the study. The study began with a small-group test involving six students, each categorized according to their level of understanding: two Very Proficient, two Proficient, and two students in need of guidance. This was followed by a large-group test involving twenty-two students.

Data collection was divided into two parts: non-test, including observation, interviews, questionnaires, and documentation, and pretest and posttest. Normality tests, t-tests, and N-Gain tests were used in data analysis to evaluate

the effectiveness of interactive multimedia based on problem-based learning.

Results and Discussion

This research focuses on the design, feasibility, and effectiveness of an interactive multimedia module based on Problem-Based Learning on the nature of matter and its changes.

Describe Interactive Multimedia Design Based on Problem-Based Learning

This research is an ADDIE model of research and development consisting of five steps, namely:

Analysis

Analysis is a stage of activity to understand and study the existing situation or conditions [18]. The purpose of the analysis stage is to determine user needs and student characteristics so that the product developed is on target [19]. At the analysis stage, information was obtained on the problems, potential, and needs in class IV of SDN Ngaliyan 03.

The researcher conducted preliminary research, namely observation, interviews, questionnaires, and documentation, in class IV SDN Ngaliyan 03, Semarang City. Based on the pre-research, the problems found in class IV SDN Ngaliyan 03 were that teachers had not optimally used technology-based learning media, resulting in low student learning outcomes, as evidenced by 64% of students not having achieved the criteria for achieving learning objectives.

The potential of SDN Ngaliyan 03 in supporting the learning process lies in its availability of fairly complete facilities. The facilities at SDN Ngaliyan 03 have projectors that can be used during the learning process, enabling teachers to deliver material visually and more interestingly. The existence of a stable internet network in the school environment is also an important factor in supporting the integration of technology in learning activities.

Researchers examined student needs as the basis for creating learning products, taking into account the possibilities and challenges they faced. For fourth-grade students at SDN Ngaliyan 03 in Semarang City, the product developed was an interactive multimedia-based problem-based learning resource.

Design

Design is the stage of initial product concept design, including material structure, appearance, and usage flow [18]. The purpose of this stage is to develop a systematic design as a guideline for product development. Planning is carried out systematically and structurally, including the development of a learning flow and initial product design. The resulting design becomes the main reference in the development process. The final result of the design stage is a prototype.

The researchers designed the product according to the needs of teachers and students, which were in line with the results of the questionnaire analysis that had been distributed [20]. This design process was carried out by considering students' characteristics and learning objectives, ensuring the media developed would be relevant and easy to use. The researchers designed interactive multimedia using Canva. Canva is a free, easy-to-use online design application that can be used as a learning medium to help students improve their creativity and innovation [21]. Canva is very easy to use for creating designs.

Researchers developed interactive multimedia using the S.Id microsite. The S.Id microsite presents material with various multimedia elements, such as text, images, videos, and interactive quizzes, which can help students understand the material more effectively [22]. S.Id microsites are designed to present information in a more interesting and interactive way to increase student engagement in the learning process [23]. The S.Id microsite has a variety of supporting components. The components of the S.Id microsite include text, images, videos, and links [24]. The S. Id microsite can be used to create a unique, interactive learning experience and introduce students to technology. In addition, interactive multimedia developed for the S. Id microsite can be accessed anytime, anywhere. This helps students repeat the learning process independently. The final result of the interactive multimedia developed using the S. Id microsite is a link that students can access using their cell phones or laptops.

The uniqueness of this research lies in the use of interactive multimedia on the S.Id website, which was specifically designed to suit the content being researched. The following images show the results of product development:

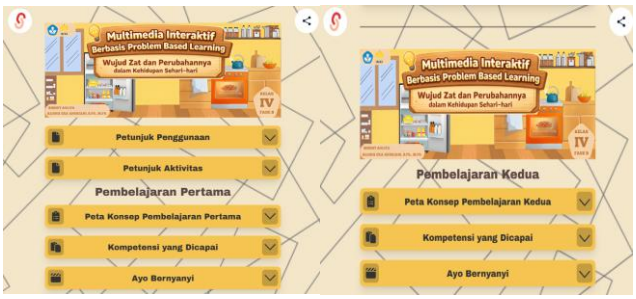

Figure 1. First and Second Learning Displays in Problem-Based Learning-based Interactive Multimedia

To help students comprehend the topics being studied, interactive multimedia based on problem-based learning is created, with a display aligned with the learning content. Additionally, interactive multimedia focused on problem-based learning is organized methodically, which facilitates students' use and access [25]. Additionally, presenting content in an engaging manner helps increase students' willingness to learn and encourages their active involvement in the process [26].

Interactive multimedia based on Problem-Based Learning uses the same syntax. Syntax 1 is to orient students to the problem, in which the teacher presents it using stimuli in the form of questions, without variation. The lack of variation in stimuli results in students not being critical in connecting the problem-solving given with the subject to be studied [8].

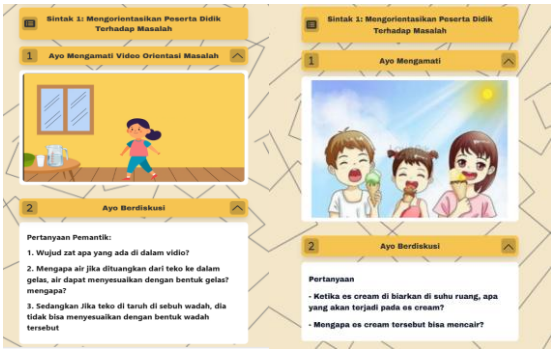

Figure 2. Syntax 1: First and Second Learning in Interactive Multimedia based on Problem-Based Learning

In developing interactive multimedia based on Problem-Based Learning, researchers applied stimulus variations in the first stage of learning during both the first and second meetings. In the first lesson, the stimulus was presented in video and text formats, while in the second lesson, a combination of images and text was used. Providing these stimuli aims to attract students' attention and help them understand the problem contextually. This stimulus variation is expected to increase students' active involvement in the learning process while developing critical thinking skills in identifying and solving problems [15].

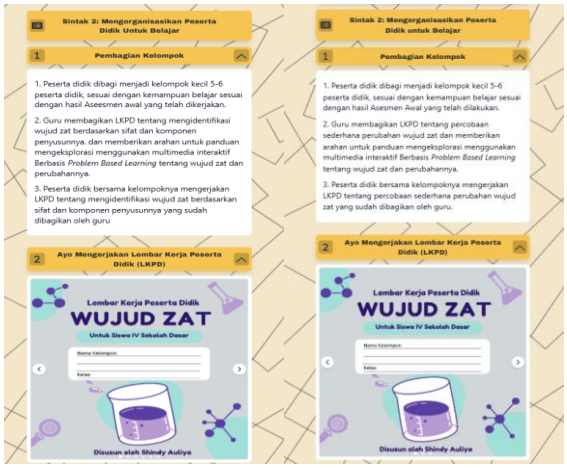

Figure 3. Syntax 2 of the First and Second Lessons in Interactive Multimedia based on Problem-Based Learning

In the second syntax, which relates to grouping students for learning, the teacher previously divided the class into groups based on front and back seating, rather than based on the results of the Cognitive Diagnostic Assessment. This heterogeneous grouping resulted in students being less than optimal in sharing knowledge due to differences in cognitive abilities [8]. In developing interactive multimedia based on Problem-Based Learning, researchers grouped students according to cognitive diagnostic results in the first and second lessons. Grouping was carried out according to the level of student understanding, namely very advanced, advanced, and requiring guidance. In addition, printed worksheets were also distributed to students. By grouping students according to their level of understanding, it is hoped that more effective collaboration among students will be fostered and a process of mutual assistance in solving learning problems will be established.

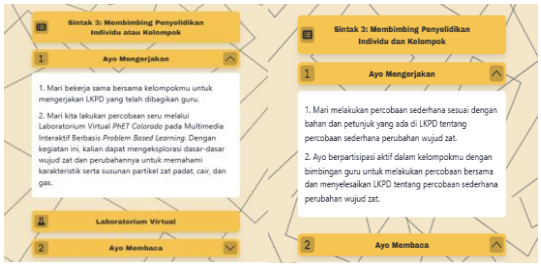

Figure 4. Syntax 3: First and Second Lessons in Interactive Multimedia based on Problem-Based Learning

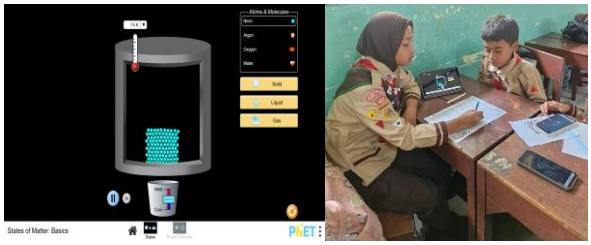

Figure 5. Use of the Virtual Laboratory when working on LKPD

In the third syntax, students receive printed worksheets and begin solving the problems given by utilizing the worksheets. Virtual laboratories and learning materials are included in interactive multimedia centered on problem-based learning. A virtual laboratory is software that provides simulations of laboratory equipment that function similarly to real equipment, thus enabling students to carry out experimental activities independently [27].

The use of a virtual laboratory in this medium is an innovation developed by researchers. The virtual laboratory used is PhET Colorado, which provides material on states of matter and serves as a stimulus for students completing worksheets. The use of a virtual laboratory aims to increase student motivation and interest in learning and assist in understanding microscopic concepts [28]. The implementation of simple practicums in the learning process can reduce misconceptions [11].

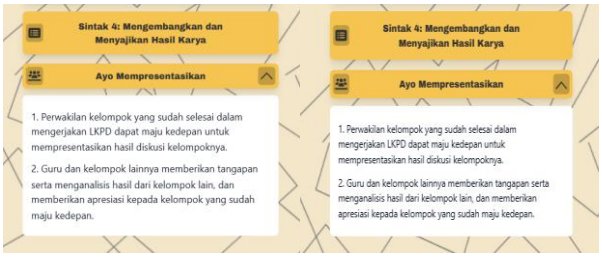

Figure 6. Syntax 4 of the First and Second Lessons in Interactive Multimedia based on Problem-Based Learning

In syntax 4, which is developing and presenting data, students who have finished working on their group results come forward to present the results of their discussion. Other groups provide additional information or suggestions. This stage encourages active and meaningful learning for students and improves critical thinking skills [15].

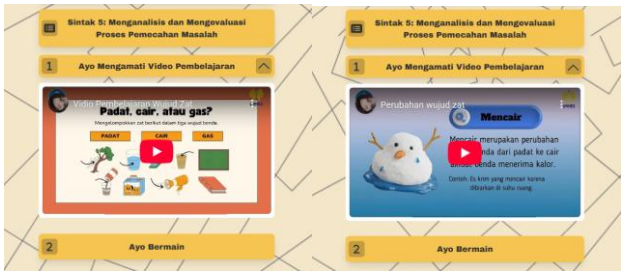

Figure 7. Syntax 5: First and Second Learning in Interactive Multimedia based on Problem-Based Learning

In syntax 5, namely analyzing and evaluating the problem-solving process. In interactive multimedia based on Problem-Based Learning, researchers create videos tailored to learning needs that cover the state of matter and its changes. Videos combining moving images and sound are able to attract students' attention and support the achievement of learning objectives [5]. Videos play an important role in attracting and focusing students' attention so that they concentrate more on the material being presented [14].

At this stage, there is an interactive edugame called Educaplay. Educaplay is a web-based application that provides many types of interactive games, such as quizzes, games, and others [29]. Educational play in learning can provide a more enjoyable and interactive learning experience [29].

Development

The development stage involves testing or trialling the product. Researchers collect materials and resources, which are then developed into interactive multimedia products based on Problem-Based Learning. Once the interactive multimedia products based on Problem-Based Learning have been developed, they undergo a feasibility test through expert validation, namely, media and subject matter experts.

To ensure that the resulting product meets quality criteria in terms of appearance, content, and application of learning models, validation is an important step to determine the feasibility of the development product [30]. Experts provide assessments and suggestions as a basis for product improvement. This process aims to ensure that interactive multimedia is suitable for use in learning, and also serves as a stage of improvement before direct testing is carried out on students [20]

Media expert validation is conducted by media experts to assess the feasibility of the developed interactive multimedia, particularly in terms of visual and technical programming. Feedback from media experts serves as a basis for improving the product to be more optimal, attractive, and ready for use in learning. Through this validation process, the quality of multimedia can be improved before it is implemented with students [31].

Content expert validation is conducted by experts with a deep understanding of the material's concepts and design. Content experts are tasked with ensuring that the content presented is in accordance with scientific principles, systematically organized, and relevant to the basic competencies in the curriculum. This validation process is carried out by professionals in their respective fields, particularly in science subjects. The assessment results are used as a basis for refining the product before testing, so that the resulting multimedia is not only visually appealing, but also scientifically accurate and effective in supporting student learning [31].

Implementation

The fourth stage in this research is the implementation stage, namely, the activity of applying the product that has been developed [20]. After undergoing expert validation and being deemed practical, interactive multimedia based on problem-based learning is implemented in actual classroom learning scenarios. This step of implementation seeks to ascertain how practical media use is, how well learning is implemented, and how students react to the created multimedia [31]. Implementation is carried out in two stages: small-group testing and large-group testing.

A small group trial of Problem-Based Learning-based interactive multimedia was conducted with six fourth-grade students at SDN Ngaliyan 03 as the initial stage of product testing. Subsequently, a large group trial involved 22 students, excluding those who had participated in the previous trial. The large group trial focused on collecting data related to student responses to the broader use of Problem-Based Learning-based interactive multimedia. The results of the field trial were then used as a basis for final revisions to perfect the developed interactive multimedia.

Evaluation

At this stage, product quality is evaluated based on student responses. Formative evaluation is conducted at each stage of development as part of the product refinement process, as well as through the distribution of questionnaires to teachers and students. Meanwhile, summative evaluation is conducted at the end of the learning activity to determine student learning outcomes related to the material presented.

Table 1. Pretest and Posttest Results

Action	Average	Improvement
Pretest	42.40	38.40
Posttest	80.91	

Based on the data in Table 1, the average pretest score was 42.40, and the average posttest score was 80.91, indicating an increase of 38.40. Thus, it can be concluded that student learning outcomes improved after the implementation of interactive multimedia based on Problem-Based Learning.

Feasibility of Interactive Multimedia Based on Problem-Based Learning

Table 2. Expert Validation Results

Expert	Percentage	Criteria
Subject Matter Expert	91.66%	Very Feasible
Media Expert	93.75%	Very Feasible

According to Table 2, material experts' validation results were 93.75%, placing it in the highly feasible group, whereas media experts' validation results were 91.66% using

the same criterion. More specifically, interactive multimedia based on problem-based learning received a score of 55 out of a possible 60 on the material expert validation questionnaire, which comprises 15 statement items. This results in a percentage of 91.66% and falls into the very feasible category. Meanwhile, the 12 items in the media expert validation questionnaire yielded a score of 45 out of 48 (93.75%), which is also considered very suitable. These results indicate that, in terms of content quality and media presentation, the interactive multimedia created meets the very feasible category.

Table 3. Teacher and Student Response Results

Respondents	Percentage	Criteria
Teacher	92%	Very Feasible
Students	95%	Very Feasible

According to Table 3, 22 students' responses had an average score of 95%, which is likewise in the extremely appropriate group, while the instructor's responses had a percentage of 92%, which is included in the very appropriate category. These results show that teachers and students who directly used interactive multimedia based on problem-based learning had many favorable things to say about it.

These findings are supported by the results of relevant research on science learning, which concluded that interactive multimedia has a very high level of feasibility and can be implemented optimally in elementary schools [32]. In addition, interactive multimedia in science learning is also stated to be very valid and practical for implementation at the elementary school level [33].

Effectiveness of Interactive Multimedia Based on Problem-Based Learning

Using SPSS software version 26, the effectiveness of interactive multimedia based on problem-based learning was then tested using the normality test, t-test, and N-Gain test.

Table 4. Normality Test Results

Action	Sig	Criteria
Pretest Test	0.93	Normal
Posttest Test	0.133	Normal

The pretest significance value was found to be 0.93 > 0.05 based on the Shapiro-Wilk normality test results in Table 4, indicating that the pretest data satisfy the assumption of normality. Additionally, the posttest data were normally distributed, as indicated by the normality test (p-value = 0.133 > 0.05).

Table 5. Paired Sample t-Test Results

Action	Mean	Improvement	Sig
Pretest	42.50	38.40	0.000
Posttest	80.91		

Based on the information in Table 5, the average pretest score for the large group was 42.50, and the average posttest score increased to 80.91, a gain of 38.40. This increase indicates a difference between students' Pretest and Posttest results after using Problem-Based Learning interactive multimedia. Furthermore, the null hypothesis (H_0) is rejected, and the alternative hypothesis (H_a) is accepted because the paired t-test results yield a p-value of 0.000 < 0.05. So, there is a difference in the average results of the pretest and posttest of students after using interactive multimedia based on Problem-Based Learning.

Table 6. N-Gain Results

Action	Mean	Improvement	N-Gain	Criteria
Pretest	42.50	38.40	0.6720	Moderate
Postest	80.91			

Based on Table 6, there is an increase in the N-Gain learning outcomes of students in the Pretest and Posttest of 0.6720, which is categorized as moderate. The increase in student learning outcomes is categorized as moderate, with an increase of 38.40. This is supported by material and media experts, who assess the results as very valid, and by teachers and students, who provide positive responses. This is caused by factors, namely, student readiness to learn and their learning styles. The smoothness of the learning process can be supported by student readiness and the support of learning strategies that can increase student focus and motivation to learn [34]. Limited time to adapt to multimedia use is also a factor affecting student learning outcomes. On the other hand, students have diverse learning styles. Although interactive multimedia has been designed to accommodate students' visual, auditory, and kinesthetic learning styles, the level of understanding of the material is still influenced by students' interest in learning science and their involvement in the learning process. Therefore, ongoing guidance and introduction regarding the use of multimedia-based Problem-Based Learning is very necessary so that its utilization can be more optimal.

Conclusion

The research findings indicate that the creation of interactive multimedia based on Problem-Based Learning (PBL) on the subject of changes in the state of matter has been methodically organized according to the stages of problem-based learning. These stages include activities that instruct students on how to identify problems, organize the learning process, direct individual and group investigations, develop and present work results, and thoroughly analyze and evaluate the problem-solving process. The PhET Colorado virtual laboratory was used as a supporting medium and learning stimulus to facilitate the implementation of virtual experiments. In addition, the interactive multimedia based on PBL received very good ratings from material experts (91.66%) and media experts (93.75%). The teacher response rate reached 92%, while the student response reached 95%, both of which are included in the very adequate category. Furthermore, the paired t-test showed a significant increase in the average pretest and posttest scores of 38.40 points ($p < 0.05$). In line with this, the N-Gain test yielded a value of 0.6720, which falls within the moderate range, indicating that the developed interactive multimedia has a positive impact on learning outcomes. It can be concluded that interactive multimedia based on Problem-Based Learning has been optimally developed, is highly feasible, and is effective in improving fourth-grade students' science learning outcomes at SDN Ngaliyan 03, Semarang City.

Author's Contribution

S. Auliya: Contributed to product development, data analysis, and was the main author of the article. A. A. Andriani: Contributed to compiling and revising research results.

Acknowledgements

The researcher would like to express her appreciation and gratitude to the Elementary School Teacher Education Study Program, Faculty of Education and Psychology, Semarang State University, for the academic support provided. She would also like to express her gratitude to Ms. Aldina Eka Andriani, S. Pd., M. Pd., as her supervisor, for her guidance, advice, and motivation throughout the research process. She would also like to express her deepest appreciation to her parents for their prayers, attention, and continued support. She would also like to thank the principal, teachers, educational staff, and all students of SDN Ngaliyan 03 for the opportunity, assistance, and cooperation provided to successfully conduct this research.

References

[1] S. Arif and A. Muthoharoh, "Pengembangan Media Pembelajaran Berbasis Powtoon dalam Meningkatkan Kemampuan Representasi IPA di Tengah Pandemi Covid 19," *Jurnal IPA & Pembelajaran IPA*, vol. 5, no. 1, pp. 112–124, Mar. 2021, doi: 10.24815/jipi.v5i1.19779.

[2] Y. Anggreni *et al.*, "analisis problematika proses pembelajaran IPA di SD," *Jurnal Inovasi Hasil Penelitian dan Pengembangan*, vol. 5, no. 2, 2025, [Online]. Available: https://jurnalp4i.com/index.php/knowledge

[3] A. Nabila Azzahra and K. Chrysti Suryandari, "Analisis Pemahaman Guru terhadap Keterampilan Proses dan Pemahaman Konsep pada Pembelajaran IPA di Sekolah Dasar," *Social, Humanities, and Educational Studies (SHES) Conference Series*, pp. 38–46, 2024, [Online]. Available: https://jurnal.uns.ac.id/shes

[4] I. R. Praja and A. E. Andriani, "Problem-based learning interactive multimedia to optimize elementary school natural and social sciences learning," *Indonesian Journal of Science and Mathematics Education*, vol. 8, no. 1, p. 136, Mar. 2025, doi: 10.24042/ijsme.v8i1.26067.

[5] Fadilah Aisyah, Nurzakiyah Kiki Rizki, Kanya Nasywa Atha, Hidayat Sulis Putri, and Setiawan Usep, "Pengertian Media, Tujuan, Fungsi, Manfaat dan Urgensi Media Pembelajaran," *Journal of Student Research (JSR)*, vol. 1, no. 2, Mar. 2023.

[6] B. Budiyono, "Inovasi Pemanfaatan Teknologi Sebagai Media Pembelajaran di Era Revolusi 4.0," *Jurnal Kependidikan: Jurnal Hasil Penelitian dan Kajian Kepustakaan di Bidang Pendidikan, Pengajaran dan Pembelajaran*, vol. 6, no. 2, p. 300, Jul. 2021, doi: 10.33394/jk.v6i2.2475.

[7] E. Melati, A. Dara Fayola, I. Putu Agus Dharma Hita, A. Muh Akbar Saputra, and A. Ninasari, "Pemanfaatan Animasi sebagai Media Pembelajaran Berbasis Teknologi untuk Meningkatkan Motivasi Belajar," *Journal on Education*, vol. 06, no. 01, pp. 732–741, 2023.

[8] S. Andi, E. Winaryati, and D. Wulandari, "pengaruh model pembelajaran problem based learning terhadap hasil belajar dan keaktifan diskusi peserta didik kelas X," *Journal of Lesson Study in Teacher Education*, vol. 3, no. 1, pp. 37–47, Jul. 2024, doi: 10.51402/jlste.v3i1.133.

[9] W. Agung, D. Pamungkas, and H. D. Koeswanti, "Penggunaan Media Pembelajaran Video Terhadap Hasil Belajar Siswa Sekolah Dasar," *Jurnal Ilmiah Pendidikan Profesi Guru*, vol. 4, pp. 346–354, 2021, doi: 10.23887/jippg.v4i3.

[10] N. W. Wardani, W. Kusumaningsih, and S. Kusniati, "Analisis Penggunaan Media Pembelajaran terhadap Hasil Belajar Siswa Sekolah Dasar," 2024. [Online]. Available: http://journal.ainarapress.org/index.php/jiepp

[11] H. Aulia, S. Suhara, and W. Surakusumah, "Keefektifan bahan ajar berbasis praktikum sederhana untuk menurunkan miskonsepsi siswa pada materi sistem pencernaan makanan," *Assimilation: Indonesian Journal of Biology Education*, vol. 3, no. 1, pp. 1–6, Mar. 2020, doi: 10.17509/aijbe.v3i1.23302.

[12] F. D. Yuliana, Susilaningsih, and Z. Abidin, "pengembangan multimedia interaktif berbasis mobile pada bahasa inggris," *JKTP: Jurnal Kajian Teknologi Pendidikan*, vol. 5, no. 1, pp. 11–21, Feb. 2022, doi: 10.17977/um038v5i12022p011.

[13] K. P. Wahyuningtiyas and S. Bachri, "Penerapan Multimedia Pembelajaran Interaktif Berbasis Mobile Learning untuk Meningkatkan Minat dan Hasil Belajar Peserta Didik," *Journal of Innovation and Teacher Professionalism*, vol. 2, no. 2, pp. 141–149, May 2024, doi: 10.17977/um084v2i22024p141-149.

[14] N. Suranda and M. Khadafi, "Macam-Macam Perkembangan Media Pembelajaran Dalam Proses Belajar Mengajar Di Indonesia," *Journal Of Social Science Research*, vol. 4, pp. 14043–14057, 2024.

[15] R. Reski *et al.*, "Pengembangan Perangkat Pembelajaran Matematika Berbasis Model Problem Based Learning untuk Memfasilitasi Kemampuan Pemecahan Masalah Siswa Kelas VIII SMP/MTs," *Jurnal Cendekia: Jurnal Pendidikan Matematika*, vol. 05, pp. 701–717, Mar. 2021.

[16] Barella Yusawinur, Naro Wahyudin, and Yuspiani, "Model-model Pembelajaran Inovatif untuk Meningkatkan Kualitas Pendidikan," 2024.

[17] Sinaga Lasmaria Agnes, "Pengembangan Multimedia Interaktif Berbasis Problem Based Learning Pada Topik Aku dan Kebutuhanku Kelas IV SD Budi Murni 1 Medan," Teacher, 2025.

[18] Sugiyono, *METODE PENELITIAN PENDIDIKAN (Kuantitatif, Kualitatif, Kombinasi, R&D, dan Penelitian Pendidikan)*, 3rd ed. Yogyaakarta: ALFABETAA, 2023. [Online]. Available: www.cvalfabeta.com

[19] F. Azizatunnisa, T. Sekaringtyas, and U. Hasanah, "pengembangan media pembelajaran interaktif game edukatif pada pembelajaran IPA kelas IV Sekolah Dasar," 2025.

[20] M. Safitri *et al.*, "ADDIE, sebuah model untuk pengembangan multimedia learning," 2022. [Online]. Available: http://jurnal.umpwr.ac.id/index.php/jpd

[21] A. P. Syahrir[1], S. P. Zahirah[2], and U. Salamah[3], "Pemanfaatan Aplikasi Desain Grafis Canva dalam Pembelajaran Multimedia di SMA Negeri 1 Taman," *Prosiding Seminar Nasional*, pp. 732–742, 2023.

[22] R. U. Situmorang, O. A. Suciptaningsih, and R. Pristiani, "microsite S.id sebagai jembatan pembelajaran ipas tentang sejarah dan budaya indonesia untuk kelas III Sekolah Dasar," *JURNAL PENDIDIKAN DASAR PERKHASA: Jurnal Penelitian Pendidikan Dasar*, vol. 11, no. 1, pp. 775–788, Apr. 2025, doi: 10.31932/jpdp.v11i1.4677.

[23] R. Febriyanti and S. F. Putri, "S.id: Platform Pintar Berbasis Artificial Intelligence (AI) untuk Meningkatkan Kemampuan Siswa SMK dalam Memahami dan Mempelajarai Administrasi Pajak," 2024.

[24] Azizi Ata Fauzi, R. Pristiani, and O. A. Suciptaningsih, "microsite S.id: platform era pembelajaran digital untuk pendidikan pancasila sekolah dasar," *Jurnal Ilmiah Pendidikan Dasar*, 2025.

[25] E. O. Melianti, "Penggunaan Media Pembelajaran Berbasis Linktree, Google form, dan Youtube Pada Materi Perkuliahan Gizi, Kesehatan dan Personality," *JAVIT : Jurnal Vokasi Informatika*, pp. 116–123, Jun. 2023, doi: 10.24036/javit.v3i2.137.

[26] K. Innoscientia, S. Azzahra, and T. Prasetyo, "Penggunaan Media Pembelajaran Digital dalam Meningkatkan Motivasi Belajar Siswa berdasarkan Persp," 2024. [Online]. Available: https://journal.innoscientia.org/index.php/jipsd/index

[27] K. M. Maryana, R. Rusdi, and R. Komala, "The Development of Virtual Laboratory Excretory System to Improve Biology Learning Outcomes for Senior High School Students," *The Development of Virtual Laboratory Excretory System ... EDUSAINS*, vol. 16, no. 2, pp. 183–191, 2024, doi: 10.15408/es.v13i2.38848.

[28] P. Ramadhani *et al.*, "Laboratorium Virtual sebagai Langkah Memaksimalkan Skill Keterampilan Siswa Virtual Laboratory as a Step to Maximize Student Skills," *Universitas Negeri Padang*, vol. 01, no. 2021, 2021, doi: 10.24036/prosemnasbio/vol1/102.

[29] W. Rizkiani, "Efektivitas Penggunaan Aplikasi Educaplay Untuk Meningkatkan Keaktifan Siswa Pada Pembelajaran Pendidikan Pancasila Kelas V," *Jurnal Pendidikan, Sains, Geologi, dan Geofisika*, vol. 6, pp. 647–651, 2025, doi: 10.29303/geoscienceed.v6i2.690.

[30] Siregar Torang and Rhamayanti Yuni, "Implementasi Pengembangan Model ADDIE pada Dunia Pendidikan," 2025. [Online]. Available: https://jurnalcendekia.id/index.php/jhpp

[31] K. Aini, I. Rosidi, L. K. Muharrami, Y. Hidayati, A. Yuniasti, and R. Wulandari, "uji kelayakan media pembelajaran videoscribe berbasis animation drawing menggunakan model ADDIE pada materi pencemaran lingkungan," 2023.

[32] Z. W. Setiadi and A. E. Andriani, "Development of Interactive Multimedia Based on Appy Pie to Improve Learning Outcomes of Elementary School Students," *Jurnal Penelitian Pendidikan IPA*, vol. 10, no. 7, pp. 4048–4057, Jul. 2024, doi: 10.29303/jppipa.v10i7.8121.

[33] N. Nur Fadila, K. Saidah, and D. D. N. Wendha, "Development of interactive multimedia based on educational games of plant parts and their functions to improve student learning outcomes," *Jurnal Pijar Mipa*, vol. 18, no. 5, pp. 666–669, Sep. 2023, doi: 10.29303/jpm.v18i5.5472.

[34] I. Marlina and F. Q. Aini, "perbedaan pembelajaran berdiferensiasi berdasarkan kesiapan dengan gaya belajar terhadap hasil belajar siswa," *EDUSAINTEK: Jurnal Pendidikan, Sains dan Teknologi*, vol. 11, no. 1, pp. 392–404, Sep. 2023, doi: 10.47668/edusaintek.v11i1.1017.