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Development of PBL-Based Smart Apps Creator Media to Improve Science Learning Outcomes for Grade IV Elementary School Students

Nora Rizkiah[1*], Sri Sami Asih[1]

[1] Elementary School Teacher Education, Faculty of Education and Psychology, Universitas Negeri Semarang, Semarang, Indonesia.

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Corresponding Author:
Nora Rizkiah
norizki08@students.unnes.ac.id

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Abstract: The use of interactive learning models and media that are not optimal in the science learning process has a negative impact on student learning outcomes. Therefore, a solution is needed to overcome these obstacles, so this study aims to develop, test the feasibility, and effectiveness of learning media in improving the learning outcomes of fourth grade students. The resulting learning media is a smart apps creator based on Problem Based Learning (PBL) about the state of matter and its transformation. The research methodology with Research and Development (RnD) using the ADDIE paradigm includes analysis, design, development, implementation, and evaluation. A total of 27 fourth grade students of SD Negeri 2 Bojongsari participated in this study. The t-test showed a significant difference between the pretest and posttest results with a significance level of 0.00 meaning less than 0.05. The N-gain test shows moderate criteria with a score of 0.55 on a small scale and 0.62 on a large scale. The results of the study indicate that the smart apps creator learning media based on problem-based learning on the material of the state of matter and its changes has been successfully developed and is very feasible and effective in improving the learning outcomes of fourth grade students of SD Negeri 2 Bojongsari.

Keywords: Learning outcomes; Problem based learning; Smart apps creator

Introduction

As a place of formal education, schools play an important role in improving the quality of education. According to Bahtilla et al. (2021) and Parker et al. (2022), education is a system of rules that helps children learn and grow into good, intelligent, disciplined, religious, and capable human beings in society. Education is an effort that aims to improve the cognitive, emotional, and psychomotor abilities of students so that they can meet their life needs in society, nation, and state, as stated in Article 1 paragraph 1 of Law of the Republic of Indonesia No. 20 of 2003. Education, as explained by Zheng (2022), is "a serious effort by teachers to help students develop as individuals so that they can realize their full potential in all aspects of life", including physical and spiritual well-being. According to Pong (2022), the ultimate goal of education is the formation of character, devotion, reasoning, and a person's ability to treat others well. Due to the pace of science and technology, "modern education" means a greater emphasis on these subjects in the classroom. This inspires teachers and students to think outside the box in order to keep up with the rapid pace of change. Technological developments will bring about changes in the learning process, one of which is curriculum renewal.

The era of revolution 5.0 which is currently developing in Indonesia, has given rise to a new policy, namely "Independent Learning" as a new curriculum. The independent curriculum is a transformation of the curriculum in Indonesia so far (Purnama & Pawiro,

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2023). The implementation of the independent curriculum as a pedagogical framework that facilitates a calm, pleasant, and stress-free learning environment, allowing students to develop their innate abilities (Quezada et al., 2021). Comparison of the independent curriculum with the previous curriculum according to (Lestari, 2023), includes First, in the 2013 curriculum with integrated thematic learning, while in the independent curriculum, learning uses subject-based learning.

In the 2013 Curriculum, there is a separate science and social studies material content and separate teaching materials are made, while in the independent curriculum, the science and social studies material content is integrated into IPAS. Finally, in the 2013 curriculum, the elementary school education level is divided into lower classes (grades I, II, and III) and upper classes (grades IV, V, and VI) and requires students to achieve learning objectives as well as possible, otherwise students will remain in that class and repeat the class again. This is different from the Merdeka curriculum where each class is divided into several phases including phase A grades I and II, phase B grades III and IV, phase C grades V and VI. If students do not complete the learning outcomes in grade I, then the students can complete the learning outcomes in the next stage. The Merdeka curriculum comprehensively measures students' abilities.

Science subject matter plays an important role in education and technological advancement. Nur'ariyani et al. (2023), describes the objectives of science education in elementary schools, namely: fostering curiosity and a positive attitude towards science, technology, and society; fostering procedural knowledge to study the natural environment, problem solving, and decision making; increasing understanding of scientific concepts that apply in everyday life; being involved in the protection, care, and preservation of the natural environment; and respecting the natural environment and regulations as manifestations of God's creation. From the results of observations and interviews with researchers, the problems that occurred at SD Negeri 2 Bojongsari, Purbalingga Regency, it was known that the learning outcomes of students in the science subject of the material on the form of matter and its changes were still low. This is because the understanding of the implementation of the independent curriculum has not been mastered by teachers, so that the science learning process is still dominated by lectures (Wardani et al., 2023).

Therefore, it causes students to feel bored with science learning whose learning activities are less interactive and innovative (Kartini et al., 2022). Conventional learning methods that are centered on teachers are still used today. Teacher learning media also use images and videos obtained from the internet and YouTube. As a result, only a small number of students show a tendency to think responsively, logically, and critically throughout the learning process in the classroom. It was also conveyed that the results of the students' science learning at SDN 2 Bojongsari also showed that out of 27 students, 14 of them had not achieved the KKTP (Criteria for Achieving Learning Objectives) at a score of 68, based on the analysis of the results of the PTS (Mid-Semester Assessment) from the teacher. Showing that there is a need to develop and implement more innovative and interactive learning methods and media to develop student learning outcomes.

According to researchers Hasanah et al. (2021), a significant problem in the classroom is the suboptimal use of interactive learning media in the science learning process, coupled with limited understanding of the implementation of the independent curriculum. Therefore, learning media and methodologies are needed that can improve learning outcomes and student involvement in the learning process. Marpanaji et al. (2018), states that learning media functions as a tool to increase the clarity of the learning process, so that it can support the achievement of educational goals effectively and efficiently. Interactive multimedia is an advancement in the development of educational media, which enhances the learning experience by allowing students to engage directly and actively with the learning materials used (Kong, 2021; Dubey et al., 2023), Interactive multimedia, such as "smart apps creator," can be used together with problem-based learning (PBL) to increase student engagement in the science learning process.

The use of effective and efficient media in the science learning process is expected to provide a stimulus that elicits responses from students' mindsets, thus facilitating the achievement of learning objectives. Rukoyah et al. (2024) and Damulawan et al. (2023), stated that smart apps creator is content software on computers and mobile devices because interactive learning is carried out with features that are very easy to understand so that the process is simplified. This program displays interesting games and may include educational materials, instructional videos, and quizzes, compatible with several platforms including PCs, laptops, tablets, and smartphones in HTML and EXE formats. To maximize student learning outcomes, educators can identify appropriate learning models and help students connect content to real-life challenges (Ariawan et al., 2024).

The learning paradigm considered is the PBL (Problem Based Learning) model. PBL (Problem Based

Learning) is a learner-centered educational approach that utilizes real-world problems as a context for students to build their own knowledge, improve learning outcomes, and develop problem-solving skills, thereby fostering independence and self-confidence (Cerino, 2023). Previous research conducted by Dewi et al. (2021) and Khotimah et al. (2023), stated that smart apps creator learning media can help students in learning and can increase the enthusiasm and interest in learning for fourth grade elementary school students.

Method

In general, this research is a researchs that aims to develop a media. Development research is a way to develop a new product or improve an old product in order to increase the usability of a system (Åkesson et al., 2024), defines the research and development process, or R&D, as a research approach used to create a particular product and test the feasibility of the product. The type of product that will be developed in this study is a PBL-based smart apps creator learning media to improve student learning outcomes in the science content of the material on the form of matter and its changes in grade IV of elementary school. This research model is the ADDIE model. The activities to be carried out consist of: analysis, design, development, implantation, and evaluation. The research design is seen in Figure 1.

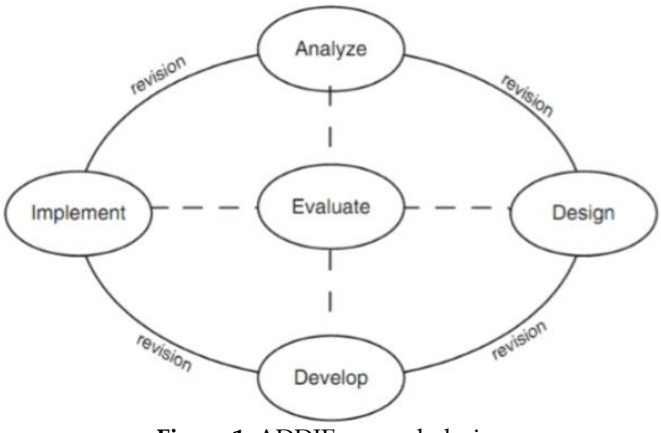

Figure 1. ADDIE research design

During the analysis phase, researchers are involved in various activities to assess the needs, characteristics of learners, learning environments, and identify various problems. At this time, observations and interviews are conducted to ensure various types of media and learning methods needed by learners, which can attract their attention and can be used based on the situation, conditions, and accessibility in the learning environment. During the design phase, researchers are involved in developing designs for educational media products "smart apps creator" based on PBL. The process of making from compiling concepts, determining devices, materials, finding background image designs, and animations related to the material of the state of matter and its changes from various sources, both teacher's manuals, student books, and the internet. The results of this design are used as reference materials in the creation and development of products. Researchers are developing learning materials in the form of applications for Android.

During the development phase, there are two components: media development based on design and expert validation. Researchers create all application assets according to the flowchart that has been set for implementation on Android devices as applications. Validation tests are carried out by specialists, especially material and media experts. Validation tests are used to obtain suggestions for improving the product and as a measure of product validation. The next stage of implementation, the researcher conducted a trial of the media on the form of matter and its changes that had been developed to determine the feasibility and effectiveness of the media in developing the learning outcomes of fourth grade students.

Results and Discussion

Analysis

Currently, there are three phases: the needs analysis phase, the study of student characteristics, and the investigation of the learning environment. During the needs analysis phase, observations and interviews were conducted to determine the specific types of learning media needed by students. Observation and interview data showed that students were quite active in the learning process; however, educators used more media such as books, pictures, and lectures. This learning method makes students less participatory, inventive, and effective. This causes students to quickly lose interest and fail to understand the content presented by educators. As a result, interesting educational resources are essential to facilitate students' understanding of the subject matter being studied.

In addition, the analysis of characteristics serves as data to determine which types of learning media are interesting to students. Technological advances have now affected many demographics, including elementary school students. Many children are already proficient in using smartphones in their routines. Observation data shows that students prefer to use smartphones to watch movies, play games, and similar activities. The display is full color, animated, and operated interactively using the touch screen buttons on the smartphone. Attractive media such as colors, fonts, graphics, and animations

that are easy to use and understand by students are needed. Next, evaluate the learning environment to ensure appropriate learning media that can be utilized by students, taking into account the circumstances, conditions, and accessibility of students. From the results of observations, the learning method in the classroom still uses lectures which make students less interactive, so a method is needed to increase interaction with the problem-based learning method. The elementary school studied has adequate internet network capabilities to support the learning process. Application-based learning media can be an effective innovation for students (Ananda et al., 2024).

Design

In the second stage, develop a product design that is in line with the analysis of the results of observations and interviews collected. Researchers develop a Storyboard for educational media goods. Storyboard as a depiction of the structure and substance of the product display, specifically focusing on educational materials related to the topic of the material and its transformation. The software intended for the creation of learning materials is "Smart Apps Creator Version 3.0". Furthermore, researchers begin collecting assets such as "backgrounds," photos, "background music," "sound effects," materials, and others to improve the development of educational media. In addition, the assessment tool includes a product validation questionnaire for material and media specialists. The pre-test and post-test consist of 25 multiple-choice questions designed to evaluate the efficacy of the learning media created in improving the academic performance of fourth-grade elementary school children (Widiastuti et al., 2022).

Development

In the third stage, the development of learning media is carried out with a previously created design (Ayuriyanti & Surjono, 2024; Susanto et al., 2022). PBL-based smart apps creator media is designed according to learning achievements and objectives (Azmi & Muchtar, 2024). Smart apps creator media is developed with a concept in the form of PBL syntax, videos of the form of matter and its changes, quizzes, and images according to the material so that it is easy to understand (Leny et al., 2021). Media smart apps creator is designed using the canva application by inserting several items and images that match the material form of matter and its changes. The size used in the development of this media is 1080 x 1920 mm, so that it fits the display size on the android screen and laptop. The final product of this media is in the form of an application for android and Exe for laptops so that it can be used directly after being downloaded and installed using an internet network to access it but when used it can be without an internet network except to access the quiz. The media smart apps creator part of the form of matter and its changes consists of:

Figure 2. Front part

Figure 3. Menu section

Figure 4. CP and TP learning 1

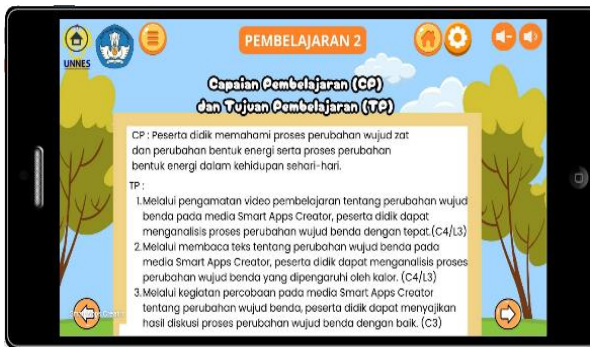

Figure 5. CP and TP learning 2

Figure 6. PBL learning syntax 1

Figure 7. PBL learning syntax 2

Figure 8. Evaluation questions

The next stage is expert validation. Validators at this level consist of a material expert who is a specialist lecturer in science and another material expert who is a specialist lecturer in multimedia (Jamil & Thohir, 2023; Dhawan, 2020; Mhlongo et al., 2023; Matthews, 2022). The results of the expert validation assessment are as follows:

Table 1. Expert Validation Values

Validation Aspects	Validation Index (%)	Information
Subject matter expert	85	Very Worth It
Subject matter expert	92	Very Worth It

Table 1 shows that the results of the validation assessment given by the material expert validator are (85%), meaning that it can be categorized as feasible. From the validation of the material expert, there are criticisms and suggestions to pay attention to the suitability of the application of the problem-based learning syntax. Meanwhile, the results of the assessment by the media expert validator are (92%), meaning that it can be categorized as feasible. The media expert validation did not provide criticism, recommendations, or revisions that were needed. Based on these results, the learning media for the form of matter and its changes can be categorized as feasible for testing (Saputro et al., 2023; Nurdyansyah et al., 2024).

Implementation

At this stage, the resulting learning media, namely "smarts apps creator" which is based on problem-based learning about matter and its transformation, is evaluated with students. The aim is to assess the efficacy of educational media in improving the academic achievement of fourth-grade elementary school children. The evaluation was carried out through pre-test and post-test questionnaires given to students. The trial was carried out on two groups, namely small and large scales. The effectiveness test was carried out using the t-test and N-gain test which were previously tested for normality (Novitasari et al., 2023; Pigai & Yulianto, 2024; Yatri & Sismulyasih, 2024). The first test carried out by the researcher was a small-scale test with 9 students. The students were given a pretest and posttest with the following results:

Table 2. Small Scale Normality Test

	Tests of Normality					
	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Large scale pretest	.208	9	.200*	.948	9	.669
Large scale posttest	.132	9	.200*	.965	9	.848

From the small-scale normality test table, the results of the pretest and posttest normality tests were obtained sequentially, namely 0.669 and 0.848. It is concluded that the data on student learning outcomes on a small scale are normally distributed.

Table 3. Small scale T-test

Paired Samples Test									
		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Large scale pretest - Large scale posttest	-22.519	6.387	1.229	-25.045	-19.992	-18.319	26	.000

Based on the small-scale t-test table, the results of the pretest and posttest mean difference test values (2-tailed) are 0.000. The t-test results show Sig. (2-tailed) 0.000 < 0.005, there is a difference.

Table 4. Small-scale N-gain Test

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Ngain	9	.29	.90	.5589	.17776
Valid N (listwise)	9				

Based on the small-scale N-gain test table, the N-gain value is 0.55 so it can be categorized as moderate. After conducting research on a small scale, research was continued on a large scale with 27 students who were given the same treatment and worked on the same pretest and posttest questions. The results of the large-scale research are as follows:

Table 5. Large-scale Normality Test

Tests of Normality						
	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Large scale pretest	.112	27	.200*	.947	27	.179
Large scale posttest	.120	27	.200*	.936	27	.099

*. This is a lower bound of the true significance.
a. Lilliefors Significance Correction

In the large-scale normality test table, the results of the protest and posttest normality tests were obtained sequentially, namely 0.17 and 0.099, so it can be concluded that the large-scale student learning outcome data is normally distributed.

Table 6. Large-scale T-test

Paired Samples Test									
		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Large scale pretest - Large scale posttest	-22.51	6.38	1.22	-25.04	-19.99	-18.31	26	.000

In the large-scale t-test table, the value (2-tailed) is 0.000. The results show that Sig. (2-tailed) 0.000 < 0.005 there is a significant difference between the pretest and posttest results.

In the large-scale N-gain test table, the N-gain value is 0.6231, which is included in the moderate category. Analysis of small and large-scale research tests, namely the results of the normality test using the Shapiro-Wilk type because the number of respondents is less than 30. The data is said to be normally distributed if Sig. > 0.05 and not normal if Sig. < 0.05. In small and large-scale tests, it is known to be normally distributed. The criteria for the paired sample t-test if the Sig. (2-tailed) < 0.05 there is a significant difference between the results of learning science on the material of the state of matter and its changes in the pretest and posttest data. If the Sig. (2-tailed) value> 0.05 there is no significant difference between the results of students' high-level thinking skills in the material of the state of matter and its changes in the pretest and posttest data.

Table 7. Large-scale N-gain Test

				Descriptive Statistics
	N	Minimum	Maximum	Mean	Std. Deviation
Ngain	27	.46	.86	.6231	.12124
Valid N (listwise)	27				

From the results of the small and large-scale tests, it is known that Sig. (2-tailed) < 0.005 so that there is a significant difference between the results of learning science on the material of the state of matter and its changes. Furthermore, the small-scale and large-scale N-gain tests obtained moderate criteria. This average increase shows that the PBL-based smart apps creator media for the material of the state of matter and its changes provides a positive change, namely increasing students' learning outcomes with an increase in pretest and posttest results (Khoirudin et al., 2021; Lee et al., 2024). The results of the N-gain test also stated that the development of learning media that was carried out obtained a percentage score of 56% and 62% with fairly effective criteria.

Evaluation

At this stage, student responses were distributed to the PBL-based smart apps creator learning media that were already good (Anjali et al., 2023; Fahlevi & Aminatun, 2023).

Conclusion

The results of the study showed that the PBL-based "smart apps creator" learning media for the material of the state of matter and its changes obtained a feasibility rating of 85% from the material expert validator, which means very feasible. This learning media obtained a score of 92% in the very feasible area from the media expert validator. The learning media that had been developed obtained an effectiveness value from the results of the small-scale and large-scale N-gain respectively of 0.55 and 0.62 which were classified as moderate criteria. It was proven that the development of the PBL-based smart apps creator learning media was feasible and effective in improving the learning outcomes of grade IV elementary school students in the subject of science on the material of the state of matter and its changes.

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Author Contributions

N. R. contributed in conducting research, product development, data analysis, and article preparation. S. S. A contributed as a supervisor in research activities until article writing.

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Conflicts of Interest

The authors declare no conflict of interest.

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