Jurnal Pedagogi dan Pembelajaran
Volume 7, Number 3, Tahun 2024, pp. 492-503
P-ISSN: 2614-3909 E-ISSN: 2614-3895
Open Access: https://doi.org/10.23887/jp2.v7i3.82690

Problem-Based Learning E-Book for Natural and Social Sciences in Fourth-Grade of Elementary Schools

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ARTICLE INFO

Article history:
Received July 14, 2024
Accepted October 02, 2024
Available online October 25, 2024

Kata Kunci:
E-Book, *Pembelajaran Berbasis Masalah, ADDIE, Ilmu Pengetahuan Alam dan Sosial*

Keywords:
E-book, Problem-Based Learning, ADDIE, Natural and Social Science

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ABSTRAK

Penelitian ini dilatarbelakangi oleh rendahnya nilai mata pelajaran Ilmu Pengetahuan Alam dan Sosial (IPAS) pada peserta didik. Hal ini disebabkan oleh kurangnya bahan ajar yang dapat mendukung pembelajaran yang berlangsung. Penelitian ini bertujuan untuk mengembangkan e-book berbasis problem-based learning pada muatan pelajaran IPAS kelas IV di Sekolah Dasar. Penelitian ini merupakan penelitian pengembangan dengan model ADDIE yang terdiri dari 5 tahapan sitematis yaitu analysis, design, development, implementation, evaluation. Subjek yang terlibat dalam penelitian ini yaitu tiga orang ahli yang meliputi ahli isi, ahli desain, dan ahli media, serta peserta didik dalam uji coba kelompok kecil sebanyak 9 siswa. Penelitian ini menggunakan metode pengumpulan data berupa wawancara, observasi, dan instrumen atau kuesioner dan tes. Teknik analisis data yang digunakan yaitu data kualitatif, data kuantitatif, dan statistika inferensial. Hasil dari penelitian ini yaitu pada uji validitas dan respon pengguna e-book mendapat kualifikasi sangat baik, serta pada uji efektivitas e-book berbasis problem-based learning dilihat dari perhitungan uji-t menunjukan terdapat perbedaan signifikan hasil belajar sebelum dan sesudah menggunakan e-book berbasis problem-based learning. Nilai post-test berada di atas KKTP. Dapat disimpulkan bahwa penggunaan e-book berbasis problem-based learning efektif untuk meningkatkan hasil belajar kelas IV pada mata pelajaran IPAS. Inovasi e-book berbasis problem-based learning pada muatan pelajaran IPAS kelas IV di Sekolah Dasar berimplikasi pada meningkatnya hasil belajar dan kemampuan peserta didik dalam materi muatan pelajaran IPAS dengan bahan ajar e-book, serta dapat mengasah kemampuan guru dalam bidang teknologi.

ABSTRACT

This study was motivated by the low achievement levels of students in the Natural and Social Sciences (IPAS) subject. This issue arises from the lack of instructional materials that adequately support the learning process. The research aims to develop a problem-based learning e-book for fourth-grade IPAS in elementary schools. This is a development study employing the ADDIE model, which consists of five systematic stages: analysis, design, development, implementation, and evaluation. The study involved three experts (content, design, and media) and nine students in a small-group trial. Data collection methods included interviews, observations, questionnaires, and tests. Data analysis employed qualitative and quantitative techniques, as well as inferential statistics. The results indicated that the e-book achieved "very good" qualifications in terms of validity and user response. Furthermore, the effectiveness test, based on t-test calculations, revealed significant differences in learning outcomes before and after using the problem-based learning e-book. The post-test scores exceeded the Minimum Competency Standards (KKTP), indicating that the problem-based learning e-book effectively improved the learning outcomes of fourth-grade students in the IPAS subject. The innovation of e-books based on problem-based learning in the content of the fourth grade science subjects in elementary schools has implications for increasing learning outcomes and student abilities in the content of science subjects with e-book teaching materials, and can hone teachers' abilities in the field of technology.

1. INTRODUCTION

Education lasts throughout life (Rohmatullah, 2023; Sihaloho et al., 2023; Nurisma, 2021). Education also provides a view of how a person can live in the world of education. Education is also an effort

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to create an atmosphere and learning process, so that later students in learning can play an active role in developing their potential, such as spiritual religious strength, self-discipline, personality, intelligence, noble morals, and other skills. Education aims to improve the quality of existing human resources with this effort human resources can go through the learning process in educational institutions (Ardiyati & Sudewi, 2023; Rahmadania et al., 2021). In the era of globalization, the development of information and communication technology (ICT) plays a very important role, especially in the field of education. This development occurs rapidly, many changes occur due to various discoveries in the field of technology, on the other hand the use of technology as a medium or communication tool is influenced by the development of technology from science. Technology is used to facilitate student learning, students at elementary school level are classified as digital because they were born in the development of rapidly developing technology (Andriyani et al., 2024; Sudarma & Adrianus, 2022). One of the characteristics that students at the elementary school level today cannot be separated from mobile phones. The positive impact of technological developments is that it provides convenience in accessing learning in education.

Each educational unit will implement a curriculum as a guideline in compiling programs, facilities and activities in an educational unit (Alimuddin, 2023; Prameswari et al., 2022). The curriculum is a set of learning plans related to the objectives, content, teaching materials and methods used and used as guidelines in organizing learning activities to achieve a national education goal. The curriculum in elementary school education units, namely the Independent Curriculum, which is one of the curriculum concepts, demands more independence for students in learning in class. The emergence of the Independent Learning Curriculum aims to realize equal education throughout Indonesia. The curriculum is a policy made by the government to create a quality next generation of the nation (Manalu et al., 2022; Wahyuningtyas et al., 2022). Changes or simplification of the curriculum occurred in the 2013 curriculum. Previously, in the 2013 curriculum, science learning and social studies learning were taught separately. So with the new policy of the independent curriculum, science learning and social studies learning are combined into the content of the social studies lesson (Andreani & Gunansyah, 2023). Science and Social Studies combined into one subject causes difficulty when students learn, because both have different characteristics of discussion material between living things and history. Science learning is one of the new subjects in this independent curriculum, it has a role in realizing the Pancasila profile (Azzahra et al., 2023; Rahmadania et al., 2021). In educational institutions, educators are educational staff who have met the requirements as teachers, lecturers, mentors, tutors, facilitators, instructors, and others, educators or teachers have a very large influence on the progress or failure of the learning process in the classroom. Educators before starting the learning process, the most important thing to do is prepare learning tools, learning tools become materials that are brought in the teaching and learning process. Management of the learning process in the classroom, things that need to be considered are skills in teaching from mastering the components of managing learning (Teluma et al., 2024; Abu, 2014).

In the learning process in the classroom, educators need to choose a learning model that can attract students to be active in the classroom. The problem-based learning model in learning activities can improve student learning outcomes, because students are encouraged to think critically and creatively (Andriyani et al., 2024; Gulo, 2022). The problem-based learning model also provides opportunities for students to express ideas, provide experiences related to ideas or ideas owned by students, this is what distinguishes the problem-based learning model from other models. In the problem-based learning model, students can develop critical and creative thinking skills to shape their knowledge through learning withe-book (Kristiana et al., 2022; Suari, 2018).

Unfortunately, the implementation of learning in the field has not been maximized as expected. Based on data from the results of interview methods, observations, and document recording carried out at SD Negeri 1 Panji Anom, information was obtained that there is still limited teaching materials at school, it is true that SD Negeri 1 Panji Anom is very lacking in teaching materials, especially in the content of science subjects due to changes in the latest curriculum. This is based on the results of interviews with the teachers concerned and from the library. Teachers spend a lot of money to print copies of the material. This is due to problems in finding material in the Merdeka Curriculum website system, namely teachers have to search for it one by one according to the material to be discussed at each meeting. Once found, the material is then printed for learning. This problem was revealed based on the results of direct interviews with teachers teaching science subjects.

Based on the results of document recording, fourth grade students have difficulty in following science learning, as evidenced by the low learning outcomes of students. Students' interest in learning is very low, as evidenced by the fact that teachers only use books from copies of each material to be studied, so this makes students' learning outcomes low, especially in science learning content. Students quickly get bored in learning, as revealed by the results of the interview. This is caused by learning in the classroom that only relies on printed books with a limited number. The use of learning media is still lacking because

many teachers still do not know the learning media that support the learning process. Sometimes teachers give examples directly with one of the objects around them according to the material being discussed. In fact, media is one of the important things in the learning process to attract student activity in learning. The number of student handbooks is limited, as evidenced by interviews that students do not have handbooks because of the change in curriculum from 2 subjects to 1 subject from the K13 curriculum to the Merdeka Curriculum. Seeing the problems above, learning media is needed to overcome the problems faced by students. One of them is through the use of digital-based learning media, namely e-books or electronic books. E-books are teaching materials that are very easy for students to use anytime and anywhere (Ardiyati & Sudewi, 2023; Amin et al., 2021). Reading e-books is much easier than printed books. In addition to being easy to read, the teaching and learning process also becomes easier. Teachers only enter the material in the form of e-books, the final result is in the form of a link, then send it to students directly and can be accessed quickly. In it there are features for developing e-books, from image, audio, and video upload features that make it easier for students to understand learning. The ongoing learning using innovative media or teaching materials also provides new and interesting experiences for students (Nurpadillah et al., 2024; Prameswari et al., 2022)

This research is supported by several previous studies related to the development of e-books. The study stated that e-book teaching materials not only teach reading, but teach to observe and practice directly on the surrounding environment. In addition, students can also learn with an audio-visual learning style, there are texts, images related to the material, learning videos, and there are several evaluations to measure students' abilities before and after learning with e-books (Prameswari et al., 2022; Wahyuningtyas et al., 2022). Other research also states that the content in e-book teaching materials is designed and developed according to the level of cognitive development of students, so that it has an impact on the ease with which students understand the material in e-book teaching materials (Wahyuningtyas et al., 2022; Puspita et al., 2021). Finally, there is research that states that e-books are an innovative learning media that can describe teaching materials that are packaged as attractively as possible (Syafani & Tressyalina, 2023; Sriwahyuni et al., 2019).

Based on previous research, this study was conducted with a novel value, namely it was specifically designed to improve student engagement and learning outcomes in science lessons. This study offers a learning approach that places students as the center of the learning process through solving real problems, which has not been widely applied at the elementary education level. In the development of e-books based on problem based learning, the material presented is not just material, but will also raise problems related to everyday life, so that it can hone students' problem-solving abilities or skills in analyzing the problems presented and finding solutions to the problems presented (Andriyani et al., 2024; Maulida, 2022).

Based on the explanation above, this research was conducted with the aim of developing an e-book product based on problem-based learning, analyzing the validity of the product, the response of e-book users, and the effectiveness of e-books based on problem-based learning on the learning outcomes of fourth grade elementary school students in the subject of science and natural sciences. Through e-book teaching materials based on problem-based learning, it is expected that the results of this study can increase the seriousness, interest, and enthusiasm of students in learning in class. Thus, it can have a positive effect on student learning outcomes in the subject of science and natural sciences.

2. METHOD

The model used in this study is the ADDIE development model. The use of the ADDIE model in this development research is based on the ADDIE model which has a systematic aspect in procedural development. The systematic steps of the ADDIE model consist of five stages, including: (1) Analysis stage, (2) Design stage, (3) Development stage, (4) Implementation stage, (5) Evaluation stage. The first stage is the analysis carried out through interview and observation activities at SD Negeri 1 Panji Anom related to the problems experienced by educators and students, namely the limited teaching materials for the new independent curriculum. The second stage is design, which is the stage for designing a product according to the needs or analysis that has been done previously. The third stage is development, which is the activity of making and testing the product where the product is made according to the design that has been made including material mapping, and designing the design. The fourth stage is implementation, which is the activity of using the E-book teaching material product that has been developed. Finally, the evaluation stage is an activity to evaluate and assess each step that has been taken so that a product can be achieved that meets the specifications that have been set.

The trial subjects or respondents for the trial of the developed product were three experts including content experts, design experts, and media experts, as well as students in small group trials of 9 students. The data collection method in this study used the interview method, observation method, instrument or

questionnaire method, and test method. The data collection instruments used included the learning content expert assessment instrument presented in Table 1, the expert assessment instrument for learning design presented in Table 2, the media learning expert assessment instrument presented in Table 3, individual and small group trial assessment instruments presented in Table 4, and the effectiveness test assessment instruments presented in Table 5.

Table 1. The Learning Content Expert Grid

No.	Aspect	Indicator	No.	Amount
A.	Curriculum	a. Suitability of materials with Learning Outcomes (CP).	1	3
		b. Suitability of the material with the Learning Objective Flow (ATP).	2	
		c. Suitability of the material with Learning Objectives (TP).	3	
B.	Material	a. Breadth of material.	4	8
		b. Material breakdown.	5	
		c. Completeness of materials.	6	
		d. Availability of supporting examples.	7	
		e. Depth of material.	8	
		f. The attractiveness of the material.	9	
		g. The material is supported with appropriate illustrations.	10	
		h. The concepts presented can be clearly explained logically.	11	
C.	Linguistics	a. Use of appropriate and consistent language.	12	6
		b. Spelling accuracy in the material.	13	
		c. Language according to EYD.	14	
		d. The sentence structure is correct.	15	
		e. Straightforward and communicative.	16	
		f. The sentence does not have double meaning.	17	
D.	Evaluation	a. Suitability of evaluation questions with learning objectives.	18	3
		b. Suitability of the level of difficulty of the evaluation questions.	19	
		c. Suitability of evaluation questions with material components.	20	
		Many Grains		**20**

Table 2. The Grid of Learning Design Expert Instruments

No.	Aspect	Indicator	Item No.	Number of Items
A.	Objective	Clarity of learning objectives.	1	
		Conformity of summary to purpose.	2	
		The learning objectives already contain ABCD (Audience, Behavior, Condition, Degree).	3	4
		Consistency between learning outcomes, ATP, learning objectives, materials, and evaluation in sequence.	4	
B.	Strategy	The instructions for completing the assignment are precise and clear.	5	
		The learning stages are sequential according to the sequence of the material.	6	
		Learning steps are written clearly.	7	
		Provide examples of events that are in accordance with the material.	8	
		The presentation of the E-book is in accordance with the steps or syntax of the Problem Based Learning learning model.	9	8
		The material presentation strategy is able to motivate students.	10	
		Provide opportunities for students to learn independently.	11	
		Accuracy of providing feedback on student answers.	12	
C.	Evaluation	Evaluations are given to measure students' abilities.	13	3

No.	Aspect	Indicator	Item No.	Number of Items
		Clarity of instructions for working on questions.	14	
		The questions presented are in accordance with the learning indicators.	15	
		Many Grains		**15**

Table 3. The Grid of Learning Media Expert Instruments

No.	Aspect	Indicator	Item No.	Number of grains
A	Technical	a. Ease of use of media.	1	2
		b. Clear instructions for use.	2	
B	Navigation	a. Ease of use of navigation feature buttons.	3	3
		b. Navigation icon layout.	4	
		c. The choice of navigation icon colors is interesting.	5	
C	Visual	a. The cover design is made attractively.	6	9
		b. The letters used are attractive and easy to read.	7	
		c. Accuracy of font size selection.	8	
		d. The placement of titles, subtitles, and illustrations does not interfere with understanding.	9	
		e. The use of font variations (Bold, Italic, all capital, small capital) is not excessive.	10	
		f. Correct use of spacing in text.	11	
		g. Choosing the right background.	12	
		h. Conformity of the image to the material.	13	
		i. Balanced layout view	14	
D	Audio and video	a. Video sound clarity.	15	6
		b. The combination of text, images and videos is interesting.	16	
		c. Accuracy of video duration.	17	
		d. Clarity of video background sound.	18	
		e. Image quality on video.	19	
		f. Clarity of sound effects.	20	
		Many grains		**20**

Table 4. The Individual and Small Group Trial Grids

No	Aspect	Indicator	No.	Amount
A.	Appearance	The E-book display is attractive.	1	4
		The writing can be read easily.	2	
		The images in the E-book are clearly visible.	3	
		The colors presented in the E-book are harmonious.	4	
B	Material	The material in the E-book is easy to understand.	5	4
		Completeness of material in the e-book.	6	
		The material in each video and image is presented clearly.	7	
		The evaluation questions/problems are in accordance with the material.	8	
C.	Motivation	*E-book*to raise enthusiasm in learning science.	9	2
		*E-book*This can increase interest in learning.	10	
D.	Operation	*E-book*it is easy to use.	11	2
		The instructions for use are easy to understand.	12	
		Many Grains		**12**

Table 5. Grid of effectiveness test instrument

Learning Outcomes	Learning objectives	Cognitive Level						Amount Question
		C1	C2	C3	C4	C5	C6	
Students utilize magnetic phenomena in everyday life, demonstrating various types of forces and their effects on the direction, movement and shape of objects.	1. Students correctly identify the use of force in daily activities.	✓			✓			1, 2, 3,
	2. Students know the nature of muscle force, friction force and use both forces appropriately.		✓					4, 5, 6,
	3. Students can apply the properties of friction to help human activities with confidence.	✓	✓		✓			7, 8, 9, 10,
	4. Students understand magnetic force and its properties correctly.	✓	✓	✓				11, 12, 13,
	5. Students can identify the types of forces produced by magnetic objects.		✓					14, 15, 16,
	6. Students can learn about the benefits and applications of magnetic force.	✓			✓			17, 18, 19, 20,
	7. Students can identify the spring force around them correctly.	✓	✓		✓			21, 22, 23,
	8. Students can learn the benefits and applications of spring force in daily activities with confidence.	✓			✓			24, 25, 26,
	9. Students can identify the gravitational force on Earth and its influence on objects on Earth correctly.		✓		✓			27, 28,
	10. Students can understand the benefits and applications of gravitational force in daily activities correctly.		✓		✓			29, 30,
Total Indicators								**30**

There are two analysis techniques in this study that are used to process data obtained from the results of the validity and effectiveness test of the E-book teaching materials. First, quantitative descriptive analysis is carried out by analyzing data in the form of numbers. Second, qualitative descriptive analysis techniques, namely data that describe an object/variable in the form of characteristics, categories, criteria, classifications (Agung, 2018). In this study, the results were obtained in the form of comments and suggestions from experts (learning content experts, learning design experts, and learning media experts) and students. The data was then processed to reach a general conclusion. In addition, inferential statistical analysis was also used to determine the level of product effectiveness on the results of learning science, especially the material of Chapter 3 Forces Around Us in grade IV students of SD Negeri 1 Panji Anom before and after using the E-book teaching material product.

3. RESULT AND DISCUSSION

Result

The product developed in this study is an e-book teaching material on the Natural and Social Sciences subject matter with the Problem Based Learning learning model in class IV of Panji Anom 1 Elementary School. The ADDIE development model is a guideline in designing this development product. This ADDIE development model has a systematic sequence of stages, first analysis, design, development, implementation, and evaluation. The first stage, namely analysis, is carried out by conducting a needs

analysis, analysis of learning materials and resources, curriculum analysis, and analysis of learning support facilities.

Based on the analysis results that have been found, the next step is to continue to the second stage, namely design. At this stage, flowchart and storyboard design is carried out, designing and compiling lesson plans, and compiling product assessment instruments. After the product is designed, it is then continued to the development stage. At the development stage, the e-book teaching material product which was initially only a storyboard is realized into teaching materials. Then the product is continued to the implementation stage, namely the application of the e-book teaching material product that has been developed. The last is the evaluation stage, namely the implemented product will be evaluated or reviewed by experts and tested on students to determine the feasibility and effectiveness of the developed teaching material product. The results of the e-book product can be presented at Figure 1.

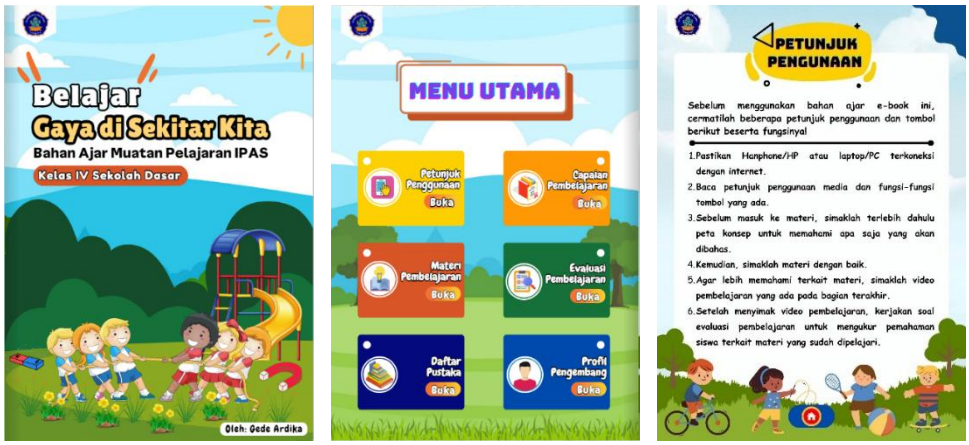

Figure 1. E-book Teaching Material Products

The developed e-book teaching materials must go through a validity test to determine whether the developed teaching materials are valid or not. The product validity test is carried out by experts/judges and user responses through individual trials and small group trials. The results of the validity test and user responses are presented in Table 6.

Table 6. The Validity Test Results and User Responses

No	Test Subject	Percentage of Results (%)	Qualification
1.	Learning content expert	94%	Very good
2.	Learning design expert	97.33%	Very good
3.	Learning media expert	93.00%	Very good
5.	Individual trials	95.56%	Very good
6.	Small group trials	95.19%	Very good

After the product is declared valid, the next step is to carry out an effectiveness test to find out. 498 level of effectiveness of the teaching materials that have been developed. Before conducting the hypothesis test, prerequisite tests were conducted, namely the normality test and the homogeneity test. The data normality test is a test conducted to determine whether the data samples analyzed really come from a normally distributed population. The formula used in the normality test is Shapiro Wilk. The results of the normality test that have been carried out using the Shapiro Wilk formula can be presented in Table 7.

Table 7. The Results of Normality Test

	Kolmogorov-Smirnov			Shapiro Wilk		
Groups	Statistics	df	Sig.	Statistics	df	Sig.
Pre-test	0.141	34	0.083	0.958	34	0.218
Post-test	0.127	34	0.179	0.956	34	0.189

Based on the calculation of Table 7, it is known that the results of the calculation using the Shapiro-Wilk formula, the pre-test value obtained was 0.218 and the post-test value obtained was 0.189. These results indicate that the level of significance in both columns is greater than 0.05, so it can be concluded that

the samples from the population are normally distributed. Then the data is continued with the homogeneity of variance test. The homogeneity test is a test used to determine whether the sample being studied is homogeneous or not. The homogeneity test is carried out using the Fisher test (f) to determine whether the sample is homogeneous or not. The results of the homogeneity test can be presented in Table 8.

Table 8. The Results of Homogeneity Test

Parameters		Levene Statistics	df1	df2	Sig.
Learning Outcomes	Based on Mean	3.510	1	66	0.065
	Based on Median	3.509	1	66	0.065
	Based on Median and with adjusted df	3.509	1	65,814	0.065
	Based on trimmed mean	3.563	1	66	0.063

Based on the calculation of Table 8, it is known that the results of the calculation of the homogeneity test of variance in the Based on Mean column show a result of 0.065. This result shows that the significance price in both columns is greater than 0.05 so that it can be concluded that the samples from the population are distributed homogeneously. After the normality test and homogeneity test are carried out, the hypothesis test is then carried out. The t-test analysis of correlated samples is carried out in testing the research hypothesis. The results of the hypothesis test can be presented in Table 9.

Table 9. The Hypothesis Test Results

Paired Groups		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pre-test Post-test	15.000	8.616	1.478	18.006	11.994	10.151	33	0.000

Based on the results of the t-test, t_{count} = 10.151 and t_{table} = 1.996 were obtained for db = n1 + n2 – 2 = 68 – 2 = 66, with a significance level of 5% (a = 0.05). Thus, $t_{count} > t_{table}$ (10.151 > 1.996) so that H_0 is rejected and H_1 is accepted. The acceptance of H_1 shows that there is a significant difference (5%) in the learning outcomes of grade IV science before and after using E-book teaching materials based on Problem Based Learning for grade IV students at SD Negeri 1 Panji Anom in the 2023/2024 academic year.

Discussion

Based on the results of the research that has been conducted, the design and development of e-book teaching materials based on problem based learning for grade IV students at SD Negeri 1 Panji Anom in the 2023/2024 academic year was carried out using the ADDIE development model. There are 5 stages of the ADDIE model, namely (1) analysis stage, (2) design stage, (3) development stage, (4) implementation stage, and (5) evaluation stage. The ADDIE development model was chosen because it has simple, systematic, clear and easy development stages. In addition, developers are given the opportunity to make changes in each stage that is passed continuously so that it will have implications for the validity of the products produced and are suitable for use in the learning process.

The effectiveness of developing e-book teaching materials based on problem-based learning, which was carried out by providing multiple-choice question sheets consisting of 20 questions to 34 fourth grade students at SD Negeri 1 Panji Anom, received a r The average pre-test score was 60.15, and the average score data was 60.15. Post test which is 75.15%. Increase The average student score can be seen based on the student's answers when answering the test. Most of the answers from students were wrong during the pre-test, but correct during the post-test. This is due to the use of e-book teaching materials during the learning process, so that students do not get bored quickly in learning.Judging from the average or mean value post test which is greater than the pre-test average value,and referring to the results of the t-test calculations, it is known that there is a significant difference in the learning outcomes of the science subject content between before and after using e-book teaching materials based on problem-based learning.

In addition to being based on the t-test, the effectiveness of this teaching material product can also be known based on the development model used in the development process, namely the ADDIE development model. Using the ADDIE model in developing e-book products is an effective approach and is developed in accordance with the analysis of user needs and learning objectives. This development model

is structured or systematic, flexible, user-oriented, evidence-based, comprehensive work stages, in each stage there is an evaluation, to ensure that the resulting product meets high quality standards, and meets the needs and learning objectives of users well (Kristiana et al., 2022; Suari, 2018). The ADDIE model helps in creating e-books that are effective, relevant and useful for users.

The effectiveness of the developed product can also be seen based on the results of the product validity test with experts, namely learning content experts, learning design experts, and learning media experts. The validity test aims to determine the feasibility of the developed product. The results of the validity test with 3 experts obtained a score in the very good qualification. It can be concluded that the problem-based learning-based e-book developed is suitable for use in the learning process. Then, the effectiveness of the developed product can also be seen based on the results of e-book user respondents conducted on grade V students through individual trials and small group trials by obtaining a score in the very good qualification. Thus, it can be stated that this teaching material is very valid and suitable for use in the learning process (Manalu et al., 2022; Wahyuningtyas et al., 2022).

The development of e-books is said to be effective because there is a combination of concepts that allow the learning process to be more interactive, easily accessible, and interesting. E-books are teaching materials that can be accessed via smartphones or computers, and are modified from traditional books (Gulo, 2022; Amin et al., 2021). In e-book teaching materials the development process by combining text with multimedia elements such as video, audio, images, and animations makes the content more interesting and helps in understanding complex concepts. Then there are interactive features such as quizzes that allow learners to actively participate in the learning process, not just listen in the learning process. Multimedia elements can sharpen the delivery of information, seen from the advantages of being able to appeal to the senses and attract interest from the combination of sight, sound and movement (Prameswari et al., 2022; Pratiwi et al., 2018). E-book teaching materials can improve learning outcomes in the content of the science subjects of Grade IV Elementary School. In addition to being able to improve learning outcomes, e-books have a positive value, namely they can improve teacher performance and improve student development. This opinion is proven through the results of previous studies which state that the application of e-book teaching materials in the learning process can improve student learning outcomes (Sainab, 2023; Maulida, 2022). E-book teaching materials can be said to be effective based on the results of the test instrument tests conducted. There are cognitive level questions remembering (C1) which are effective in improving learning outcomes in the learning process because e-book teaching materials contain multimedia elements, namely learning videos, images and infographics, audio, animation, interactive, and case examples that can train students' memory. This is in line with the opinion that states that videos that can present moving images to students, in addition to the accompanying sound, increase students' memory of the material being studied (Azzahra et al., 2023; Fitri & Ardipal, 2021).

Questions about the cognitive level of understanding (C2) are said to be effective because there are several effective media to support the achievement of the cognitive level of C2 understanding, namely: explanatory videos, illustrations, quizzes and interactive exercises. Utilizing these various media in the developed teaching materials, e-books can provide a comprehensive and in-depth learning experience, helping learners understand and remember concepts at level C2 more effectively. Effective textbooks are used to reflect learning and have a major impact on the quality of learning (Andreani & Gunansyah, 2023; Ardiyati & Sudewi, 2023). There are questions on the cognitive application level (C3) in the problem-solving exercise section in the developed teaching materials. Teaching materials should be designed to help students use the knowledge they have learned in new contexts or real situations. This study has advantages because it can facilitate students in understanding the material contextually and improve critical thinking skills through solving real problems (Manalu et al., 2022; Wahyuningtyas et al., 2022). By designing challenging questions, students can apply their knowledge and educators can ensure that learning becomes more effective and useful. This is in line with the opinion that states that the higher the level of competence or cognitive level, the greater and more complex the intensity of learning experiences and knowledge of students in the learning process and assessment (Sudarma & Adrianus, 2022; Wahyuningtyas et al., 2022). The developed teaching materials already contain cognitive level C4 questions on learning evaluation questions supported by the presentation of illustrations and several real examples in everyday life. Analyzing is the process of breaking down complex information into simpler and more systematic parts to understand the structure, relationships, and functions of the information. In this case, e-books are intended to help students understand and analyze materials according to their level of cognitive development and the use of technological advances in the learning process (Prameswari et al., 2022; Rahmadania et al., 2021). Then, it can be said to be effective when seen from the product developed. The suitability of the material with CP, ATP, and TP is in accordance with that presented in the e-book teaching materials. CP is something that is to be achieved, after CP is compiled, an understanding is needed to reduce it to TP. The TP that has

been compiled then compiles ATP to make it easier for teachers to achieve TP according to JP so that it is more effective (Setiawan, 2022).

Judging from the quality of the display, the appearance of e-books plays an important role in increasing students' interest in learning. E-books that have high display quality can create a more interesting, interactive, and effective learning process, and most importantly can increase student interest and involvement. This is in line with research that states that e-books can be used to increase students' interest in reading and learning, so that students continue to be motivated in the learning process and increase their interest in learning (Andriyani et al., 2024; Sudarma & Adrianus, 2022).

Relevance or relatedness of the material, the relevance of the material in e-book teaching materials aims to ensure that the presentation of the material is useful, interesting, and easy to understand. Relevance is that there is a match or consistency between other components such as objectives, content, delivery process and evaluation. Evaluation of user involvement, evaluation by involving users to ensure that the teaching materials provided not only meet high quality standards but are also effective in supporting the learning process and achieving the desired learning objectives. The use of attractive colors in e-book teaching materials has an important role in the material presented. The use of colors wisely and strategically, e-books can improve user experience, facilitate understanding, and improve memory. Each color contains aesthetic elements that must be considered carefully by developers of learning products. The selection of appropriate colors will make the design of learning products more communicative and aesthetic. There are visualizations related to appropriate materials, by using appropriate and relevant visualizations, in e-book teaching materials can improve the reader's experience, facilitate understanding of the material, strengthen effectiveness, and foster students' interest in learning. Visual media can foster student interest and can provide a connection between the content of the subject matter in the teaching materials and the real world (Naimnule et al., 2023; Brignardello-Petersen, 2018). Learning videos in e-book teaching materials can provide many benefits and increase the effectiveness of learning, and facilitate student understanding. Videos are also non-printed teaching materials and are rich in information. Learning video media can present information, explain processes, explain complex concepts, teach remembering or extend the memory period of attitudes (Azzahra et al., 2023).

Interactive features or feedback in e-book teaching materials can provide significant benefits in improving the learning experience, learning outcomes, and learning effectiveness, and can be a powerful tool in conveying information, motivating learning, engaging students to be active and improving the experience for students. Feedback in teaching materials is in the form of providing information on whether or not the student's answer to the questions/questions given is correct, through this feedback it is possible to determine the level of student understanding related to the material that has been studied. Effectiveness*e*-book also because ofthere is an increase in learning enthusiasm and interest in learning that influences a person's learning behavior positively and sustainably, which is reflected in increased involvement, achievement, and persistence in learning. These results are in line with research stating that E-books are one of the effective and feasible teaching materials to be developed, and allow students to access, understand, and use information more effectively and enjoyably, acquire knowledge, attitudes, and skills more efficiently, and faster (Andriyani et al., 2024; Kristiana et al., 2022). Innovation of e-book teaching materials based on problem-based learning in the content of science subjects for grade IV at SD Negeri 1 Panji Anom is effective in improving student learning outcomes. This research on the development of e-book teaching materials has implications, namely expanding teacher knowledge in developing and utilizing e-book teaching materials in the learning process, so that there are many learning methods in learning. This study shows that the use of e-book teaching materials can improve student learning outcomes and understanding in science subjects. In addition, this study encourages teachers to utilize existing technology in schools, which indirectly improves teacher skills in operating learning media. The limitation of this study is the limited test subjects. This study can be used as a reference source and basic reference in conducting another research. Subsequent research can improve the limitations of this study by conducting similar research in a wider scope.

4. CONCLUSION

Validity of the e-book teaching materials based on problem-based learning that have been developed based on expert reviews, namely the results of the review by learning content experts received very good qualifications, by learning design experts received very good qualifications, and by learning media experts received very good qualifications. The response of users of e-book teaching materials based on problem-based learning that have been developed based on reviews of product trials, namely individual trials received very good qualifications and small group trials received very good qualifications. Based on the data that has been presented, it can be concluded that the e-book teaching materials based on problem-

based learning that have been developed are suitable for use in learning. Then based on the effectiveness test, it was concluded that the innovation of e-book teaching materials based on problem-based learning was declared effective in learning to improve learning outcomes of the content of science subjects in grade IV of SD Negeri 1 Panji Anom.

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