The Development of E-Books Based on Problem Based Learning to Improve Science Learning Outcomes

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Abstract: This research aims to develop and test the validity and effectiveness of e-books based on Problem-based Based Learning to improve science learning outcomes for class V students. The type of research used is Research and Development with the Borg and Gall research model. The subjects in this study were 26 Class V students. The data collection technique used test techniques (pretest and posttest); and non-test techniques (observation, interviews, and questionnaires). Data analysis techniques include initial data with normality and homogeneity tests; and final data analysis using the t and N-gain tests. The research results show: (1) Problem-Based Learning-based e-books were developed using the book creator application with cover components, KD, indicators, learning objectives, instructions for use, concept maps, single and mixed substance material, learning evaluation, developer biography, and bibliography ; (2) the validity test results of material experts, media experts, teachers and students are in the very appropriate category; (3) effectiveness is seen from the results of the analysis of posttest and pretest scores. The t-test results obtained a sig value. Equal to $0.000 > 0.05$. The N-gain test result was 0.69 in the medium category. The conclusion from this research is that the development of an e-book based on Problem-Based Learning has been successfully developed, and is very feasible and effective for improving the science learning outcomes of class V students.

Keywords: e-books; Natural sciences; Learning outcomes; Problem based learning

Introduction

Education is one of the most important factors for a nation's progress (Aufa et al., 2020; Devi et al. 2022). Based on Law No. 20 of 2003 concerning the National Education System explains that education is a planned effort to create a learning atmosphere and process so that students can actively develop their potential through the aims and functions of national education. To realize the goals and functions of national education, a curriculum is prepared. In implementing the 2013 curriculum, there are objectives contained in Permendikbud No. 67 of 2013 concerning the Basic Framework and Structure of the Primary School/Madrasah Ibtidaiyah Curriculum which explains that "The 2013 Curriculum aims to prepare Indonesian people to have the ability to live as individuals and citizens who are faithful, productive, creative, innovative and affective and able to contribute to life society, nation, state, and world civilization". To achieve this goal, the government issued Minister of Education and Culture Regulation No. 22 of 2016 concerning Competency Standards for Primary and Secondary Education Graduates which explains that "The learning process in educational units is carried out in an interactive, inspirational, fun, challenging manner, motivating students to participate actively, and providing sufficient space for initiative, creativity and independence following talents, interests, and physical and psychological development of students. "For this reason, each educational unit carries out learning

planning, implementing the learning process, and assessing the learning process to increase the efficiency and effectiveness of achieving graduate competencies."

Based on Minister of Education and Culture Regulation No. 21 of 2016 concerning Content Standards for Primary and Secondary Education Units states that one of the lesson contents in the SD/MI curriculum is Natural Sciences (IPA). Natural science is a learning concept that studies all natural phenomena and has a very broad and comprehensive relationship to human life, plants, animals, and inanimate objects (Agus et al., 2021; Sappe, Ernawati, & Irmawanty, 2018). Therefore, science learning should begin with the introduction of contextual problems (Afifah & Minsih, 2021). The aim of science learning in elementary school is to develop students' ability to think, work, and behave scientifically to obtain science knowledge, concepts, and skills as a basis for continuing to the next level (Khalida & Astawan, 2021). To achieve science learning objectives, the teacher needs to use models, learning methods, and teaching materials that are appropriate to the characteristics of the material and students (Wijayama, 2020). Teachers are the main component who occupy the main position in teaching activities (Susanto, 2020). So it is expected that teachers have high professional skills and characteristics to achieve learning goals. Teachers must be able to expand teaching materials that are attentive, efficient, and effective (Maulida, Adnyana, & Bestari, 2022).

However, the implementation of science learning in elementary schools is not yet by the expected goals. The Educational Assessment Center (Puspendik) stated that based on the 2015 Trends in International Mathematics and Science Study (TIMSS), which measures the Mathematics and Science achievements of grade 4 SD/MI students in international studies, Indonesia was ranked 46th out of 51 TIMSS participants with a score of 397 while the score the international average is 500 (Retnowati & Ekayanti, 2020). This shows that students in Indonesia in science subject content are still ranked at the bottom and lagging behind countries in the world. The low success of learning is caused by several things, namely conventional teacher learning methods, teachers being the only source of learning, the models and learning methods used by teachers are less varied, teaching materials and learning media are limited (Dewi & Izzati, 2020; Lestari, 2022)

The problems found by researchers based on the results of observations and interviews with class V teachers at SDN Ngemplak Simongan 02 Semarang included limited sources of teaching materials and learning media used to support science learning. Teachers only use resources from textbooks. Teaching materials should not only be obtained from one source

because this will not maximize student learning outcomes (Magdalena, Kurniawati, & Pertiwi, 2020). The teaching materials provided by schools contain short material, and limited images and do not utilize technology-based learning, causing students to get bored and not interested in taking part in the ongoing learning. The teacher's learning model is not following the implementation of the 2013 Curriculum where teachers dominate during learning and have not implemented a learning model that can sharpen problem-solving skills in science lesson content. This problem causes the science learning output of class V students at SDN Ngemplak Simongan 02 Semarang not to meet the Learning Completeness Criteria (KKM). The KKM for the science subject content is 75. Data on the value of the science subject content shows an incomplete percentage of 85% with details of the total number of students being 26 students with 11 male students and 15 female students. Of the 26 students, only 4 students completed it while 22 students did not complete it.

Based on the problems that have been described, the solution offered by researchers is to develop electronic teaching materials, namely e-books based on Problem-Based Learning. E-books were chosen because they allow teachers to present material that is varied and easy for students to understand through components that can be integrated into e-books such as pictures, audio and video lessons (Hanikah, Faiz, Nurhabibah, & Wardani, 2022). E-books play an important role in the learning process because they can improve learning outcomes, make learning more effective and efficient, and are not as outdated as printed books (Anwar, Alimin, & Munawwarah, 2021).

The e-book will be prepared based on a learning model by government recommendations in the 2013 Curriculum, which is Problem-Based Learning. The Problem-Based Learning learning model is a learning model that uses a student learning approach to problems to stimulate students' higher-level thinking and make students actively involved in the learning process. (Ariyani & Kristin, 2021; Lisnawati, Suroyo, & Pribadi, 2022; Nurbaeti, 2019). In line with previous research (Ningsih, Ahmad, & Amini, 2019) state that to optimize learning outcomes, the Problem-Based Learning model is combined with problem-solving steps in learning. It is hoped that this Problem Learning-based e-book can be used as teaching material that is practical and makes it easier for students to understand improves student learning outcomes, and improves students' problem-solving abilities.

The objectives of this research consist of (1) developing an e-book based on Problem-Based Learning; (2) testing the validity of e-books based on Problem-Based Learning; (3) testing the effectiveness of

e-books based on Problem-Based Learning to improve science learning outcomes for class V SDN Ngemplak Simongan 02 Semarang.

Method

This research type is Research and Development (RnD). According to Sugiyono (2022) research and development methods can be said to be a scientific way to design, research, produce, and test the validity of the products produced. In research and development of e-books based on Product-oriented Problem-Based Learning using the Borg & Gall model. The Borg and Gall model has 10 stages in conducting development research, namely (1) potential and problems; (2) data collection; (3) product design; (4) design validation; (5) design revision; (6) product testing; (7) product revision; (8) trial use; (9) product revision; (10) mass production (Sugiyono, 2022). However, the implementation of this research only reached step 8, namely trial use. Several development studies that have been obtained show that the 10 stages of Borg and Gall's development cannot be carried out in all, but can be modified into several steps and stages according to the development needs carried out by researchers (Effendi, 2018).

The research was conducted at SDN Ngemplak Simongan 02 Semarang. Research subjects included 26 class V students at SDN Ngemplak Simongan 02, class V teachers at SDN Ngemplak Simongan 02, media experts, and material experts. Data collection techniques in this research used test and non-test techniques. Test techniques are carried out through pretest and posttest, while non-test techniques are carried out through observation, interviews, and questionnaires. Initial data analysis with prerequisite tests includes normality test and homogeneity test. Final data analysis includes a t-test and N-Gain test.

Result and Discussion

This research is research regarding the development of an e-book based on Problem-Based Learning on science lesson content with single and mixed substance material for class V of SDN Ngemplak Simongan 02 Semarang. From the results of the research that has been carried out, several things will be studied in the results and discussion, namely: (1) the results of the development of e-books based on Problem-Based Learning; (2) the feasibility of e-books based on Problem-Based Learning; (3) the effectiveness of e-books based on Problem Based-Learning based on pretest and posttest results in the use of e-books based on Problem Based Learning in science lesson content on single and mixed

substances for class V of SDN Ngemplak Simongan 02 Semarang.

Development of E-Books Based on Problem Based Learning

This research and development uses the Borg and Gall model. The first stage is potential and problems. To find out the potential and problems that exist at SDN Ngemplak Simongan 02 Semarang, observations were carried out through interviews, documentation, and data in the form of learning outcomes of class V students at SDN Ngemplak Simongan 02 Semarang. Based on observations that have been made, show that: there are limited sources of science teaching materials and learning media; not yet utilizing technology-based learning; and the learning method used by teachers is still conventional, namely the lecture method, thus influencing student learning outcomes in science learning. To overcome these science learning problems, researchers studied research into the development of e-books based on Problem-Based Learning on science lesson content with single and mixed substance material.

The second stage is data collection. The required data collection is student learning outcomes and a survey of teacher and student needs regarding the development of e-books based on Problem-Based Learning. Based on observations, student learning outcomes in science lesson content were low. The results of the survey analysis of teacher and student needs stated that there is a need for IT-based interactive teaching materials by utilizing existing infrastructure. Students need e-books based on Problem-Based Learning which are accompanied by pictures, audio, video, and learning evaluations which are packaged attractively in single and mixed substance material.

he third stage is product design. Problem Based Learning based e-books are designed using the bookcreator application with the final file being in the form of a link. Problem-Based Learning e-book teaching materials consist of various types of media including text, images, sound, and learning videos. The Problem-Based Learning-based e-book contains a cover, KD, indicators, learning objectives, instructions for use, concept map, and material on single and mixed substances, learning evaluation, developer biography, and bibliography. The syntax of Problem-Based Learning includes (1) student orientation to the problem; (2) organizing students to learn; (3) guiding individual/group investigations; (4) developing and presenting results; (5) analyzing and evaluating the problem-solving process (Agustin & Razi, 2023; Herdianto et al. 2021; Setiawan et al. 2022).

The fourth stage is design validation. Validation of e-book designs based on Problem-Based Learning is

carried out by experts, namely material experts and media experts. The fifth stage is design revision. Revisions to the e-book design based on Problem-Based Learning were carried out based on assessments and suggestions from material experts and media experts until it was suitable for testing.

The sixth stage is product testing. Testing activities were carried out in small groups to obtain suggestions on the effectiveness of Problem-Based Learning e-books. The small group trial was carried out at SDN Ngemplak Simongan 02 Semarang with 6 class V students. After the experiment was carried out, the researcher distributed teacher and student response questionnaires to

determine the response of teachers and students to e-books based on Problem-Based Learning on science lesson content with a single substance and mixture.

The seventh stage is product revision. Based on the results of teacher and student response questionnaires in small-scale trials, there were no product revisions because they were appropriate.
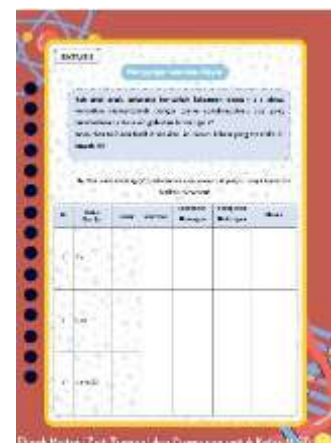
The eighth stage is trial use. At this stage, a large-scale trial was carried out in class V of SDN Ngemplak Simongan 02 Semarang with a total of 26 students. The results of the development of an E-Book based on Problem-Based Learning are presented in **Figure 1-6.**

Figure 1. Problem Based Learning E-book Cover

Figure 2. Student Orientation to Problems

Figure 3. Organizing Students for Learning

Figure 4. Guiding Investigation

Figure 5. Developing and Presenting Work Results

Figure 6. Analyzing and Evaluating the Problem Solving Process

Feasibility of E-Books Based on Problem Based Learning

The feasibility of Problem-Based Learning e-books on single and mixed-substance material is determined based on the results of validity tests by material experts, media experts, teacher responses, and student responses. Validation results can determine the

suitability of the product and product revision guidelines that have been created (Agustin et al. 2023). Validity testing is carried out by distributing assessment instruments with several aspects. Aspects of the material expert assessment instrument include (1) competency; (2) material suitability; and (3) language proficiency. Aspects of the media expert's assessment instrument

include (1) suitability of the topic; (2) appearance; (3) usage; and (4) excellence. Aspects of teacher and student assessment instruments include (1) content; (2) language; and (3) presentation. The validity test results are presented in **Table 1.**

Table 1. Validity Test Results of Material Experts and Media Experts

Respondent	Percentage	Description
Material expert	87.5	very worthy
Media expert	90	very worthy
Teacher	100	very worthy
Student	97	very worthy

Based on the results of **Table 1**, it is shown that the results of the validity test of e-books based on Problem-Based Learning from material experts obtained a percentage of 87.5% in the very feasible category, and media experts received a percentage of 90% in the very feasible category. The results of teacher responses obtained a percentage of 100% in the very appropriate category and student responses obtained a percentage of 97% in the very appropriate category. Previous research findings also state that the use of e-books based on Problem-Based Learning is very suitable for use in learning (Dwikoranto et al. 2023; Herdianto et al. 2021). It can be concluded that e-books based on Problem-Based Learning are very suitable for use in learning.

Effectiveness of E-Books Based on Problem-Based Learning
The effectiveness of e-books based on Problem-Based Learning with single and mixed substance material is determined based on student learning outcomes by analyzing student pretest and post-test scores. Researchers conducted experiments using a pre-experimental design, a one-group pretest-posttest design model. The results of the pretest and posttest are presented in **Table 2.**

Table 2. Pretest and Posttest Test Results

Aspect	Pretest Score	Posttest Score
Mean	48.23	83.38
Highest Score	64	100
Lowest Score	40	76

Based on Table 2, it is known that there is an average increase in learning outcomes from the pretest score of 48.23 to 83.38 in the post-test score. This research uses initial data analysis and final data analysis using the help of the SPSS 25 program. Initial data analysis includes normality tests and homogeneity tests. Final data analysis includes a t-test and N-Gain test.

The normality test is used to determine whether research data is normally distributed or not. The normality test in this study used the SPSS 25 program with Kolmogrov-Smirnov. The results of the normality test are presented in **Table 3.**

Table 3. Normality Test Results of Pretest and Posttest Data

		Pretest	Post-test
N		26	26
Normal Parameters[a,b]	Mean	48.23	83.38
	Std. Deviation	8.126	7.217
Most Extreme	Absolute	.191	.180
Differences	Positive	.191	.180
	Negative	-.138	-.153
Test Statistic		.191	.180
Asymp. Sig. (2-tailed)		.160[c]	.291[c]

a. Test distribution is Normal.
b. Calculated from data.
c. Lilliefors Significance Correction.

The normality test criterion is that the data is normally distributed if the sig value. (2-tailed) > 0.05, and vice versa if the sig value. (2-tailed) < 0.05 data is not normally distributed. Based on Table 3, it is known that the sig value. (2-tailed) which refers to the Kolmogrov-Smirnov test, pretest data 0.160, and posttest data 0.291. The significance value for both research data is more than 0.05, so it can be concluded that the pretest and posttest research data have a normal distribution.

The homogeneity test is used to determine whether the research data comes from the same population or not. The homogeneity test in this study used the SPSS 25 program. The homogeneity test results are presented in **Table 4**.

Table 4. Homogeneity Test Results of Pretest and Posttest Data

	Levene Statistic	df1	df2	Sig.
Based on Median	1.236	1	50	.272
Based on Median and with adjusted df	1.236	1	49.870	.272
Based on trimmed mean	1.318	1	50	.256

Based on Table 4, it is known that the significance value (Sig.) Based on the Mean is 0.256>0.005. So it can be concluded that the data variance is the same or homogeneous. Based on the results of the prerequisite tests, it can be concluded that the research data is normally distributed and homogeneous, so a Paired T-test can be carried out using SPSS 25 to find out the effectiveness of e-books based on Problem-Based Learning. The results of the Paired T-test are presented in **Table 5**.

Table 5. Paired T-test results

	Paired Differences					t	df	Sig. (2-tailed)
				95% Confidence Interval of the Difference				
			Std. Error					
	Mean	Std. Deviation	Mean	Lower	Upper			
Pretest - Postest	-35.077	3.006	.589	-36.291	-33.863	-59.508	25	.000

The test criteria for the Paired T-test is if the sig value. (2-tailed) > 0.05, so there is no significant difference in the pretest and posttest results. Based on **table 8**, sig. (2-tailed) 0.000 < 0.05, indicating that there is a significant difference between the pretest and posttest results with an increase of 35.07%. So it can be concluded that e-books based on Problem-Based Learning are effective for use in learning, especially in science lesson content. The N-gain test is used to determine the average increase in pretest and posttest. The N-gain test in this research used the SPSS 25 program. The N-gain test results are presented in **Table 6.**

Table 6. N-Gain Test Results

Action	Average	Average Difference	N-gain	Category
Pretest	48.23	35.08	0.69	Medium
Postest	83.31			

Based on **Table 6**, the results of the N-gain test show that the learning outcomes of class V students at SDN Ngemplak Simongan 02 Semarang using Problem-Based Learning-based e-books experienced an increase in the average N-gain score of 0.69 in the medium category. This is in line with the findings of previous researchers (Irawati, 2023; Kristiana et al. 2022; Kusumatuty et al. 2018) stating that e-books based on Problem-Based Learning are effectively applied in learning and can improve student learning outcomes.

Data analysis and research showed that the validity test results showed a very feasible category on the assessment instrument and the N-gain test results showed a medium category. This is due to variations in students' learning readiness, study habits, and different learning styles to achieve a higher understanding of the material and learning outcomes. Based on the data analysis that has been carried out, it can be concluded that the use of e-books based on Problem-Based Learning is effectively applied in learning.

Conclusion

Development of an e-book based on Problem-Based Learning on science lesson content on single and mixed substances using Research and Development (RnD) research with the Borg and Gall model which is adapted to research needs. E-books based on Problem-Based Learning were declared very suitable for use in learning, obtained from the results of material expert validity tests with a percentage of 87.5% and media expert validity tests with a percentage of 90%. E-books based on Problem-Based Learning were declared effective for use in learning in terms of increasing learning outcomes in the cognitive domain in science lesson content on single and mixed substance material through analysis of pretest and post-test scores. The results of the Paired T-test analysis show sig. (2-tailed) 0.000 < 0.05 and the N-gain test result is 0.69 in the medium category. Research on the development of e-books based on Problem-Based Learning was successfully developed, very feasible, and effective for improving the science learning outcomes of class V students.

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