

## Development of Interactive E-Books Based on Problem-Based Learning on the Material of the Earth's Surface Layers

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**Abstract:** Limited sources of interactive electronic-based teaching materials can result in low cognitive learning outcomes for students, especially in science learning. This study aims to describe the development design and test the feasibility and effectiveness of Interactive E-Books based on Problem Based Learning in improving science learning outcomes in grade V students of SDN Ngijo 01 Semarang City. This research and development (RnD) study uses the Borg and Gall model. Data collection techniques are tests and non-tests, tests with (pre-test and post-test), and non-tests in the form of observations, interviews, questionnaires, and documentation. Data analysis was carried out using normality tests, t-tests, and N-Gain. The results of the study indicate that the development design of Interactive E-Books based on Problem Based Learning was successfully developed with the Canva and Flipbook applications, its components such as the main page, foreword, advantages of e-books, table of contents, instructions for use, activity instructions, achievement indicators, concept maps, materials based on Problem-Based Learning syntax, interactive learning videos, LKPD, educational games, and developer profiles. The feasibility of the interactive e-book from material and media experts is very feasible, supported by teacher and student assessments, which also show a very feasible category. The novelty of this study lies in the presentation of material that applies the syntax of the Problem-Based Learning model, which includes stimulus variations, grouping, presentation of results, and reflection, as well as the integration of interactive elements such as images, videos, and sounds. There are interactive edugames to facilitate understanding of the concept of the earth's surface layers. The effectiveness of the E-Book is shown by an increase in value of (15.25) supported by the results of the t-test (0.001) and the N-Gain score of (0.50) in the medium category. The research that has been conducted shows that the conclusion of this study shows that the Interactive E-Book based on Problem Based Learning has been successfully developed, is very feasible, and effective in improving the science learning outcomes of grade V students of SD N Ngijo 01 Semarang City on the material of the earth's surface layers.

**Keywords:** Earth's Surface Layers; Interactive E-Book; Learning Outcomes; Problem-Based Learning; Science Learning.

### Introduction

Natural Science is a science that focuses on understanding living things, the natural environment, and their interactions, including the role of humans in it [1]. Natural science has the essence of products, processes, attitudes, and technology, which makes students experience a complete learning process in understanding natural phenomena; thus, science learning must be applied wisely. The main goal of science learning is for students to use their knowledge to explore, investigate, and understand the surrounding environment while practicing scientific attitudes such as critical thinking and problem-solving [2].

Science learning significantly contributes to the development of science education in Indonesia, especially when facing global challenges in science and technology. The research conducted can also be a reference for teachers in choosing technology-based learning methods to improve learning outcomes and to be able to incorporate learning into everyday life [3]. The main objective of science learning is to develop students' scientific Mastery of thinking, working, and behavior abilities [4], as well as knowledge, concepts,

abstract material, and science skills, will be the basis for continuing higher education.

Technological developments provide significant solutions to help students understand and comprehend abstract science learning materials [5]. Technology-based learning materials, such as interactive e-books, can present visualizations of these concepts through animations, simulations, and other interactive tools. Technology-based learning materials make science learning more enjoyable, easy to understand, and relevant to the needs of students in the digital era. In addition, technology-based learning materials help present abstract material to be more concrete and easy to understand and support the development of exploration, analysis, and problem-solving skills so that science learning objectives can be achieved optimally in science learning; technology-based learning materials such as Interactive E-Books are needed [6].

Interactive E-Books are digital technology-based learning materials that contain structured and interactive material [7]. In this context, Interactive E-Books present learning materials and integrate interactive features such as video, images, sound, and interactive games in one unit [8].

### How to Cite:

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They can also be used as an alternative learning resource that can be accessed anytime and anywhere [9].

The development of science learning is very important to ensure that students understand the concept of science learning well and can apply it in everyday life. Therefore, teachers are responsible for creating quality and effective teaching materials and implementing optimal innovative learning models so that they can support students' learning processes.

Problem-Based Learning is an innovative learning model that is carried out to improve skills in problem-solving and critical thinking in learning. Problem-based learning can create students who can solve real problems and develop problem-solving skills [10]. So, by integrating Interactive E-Books and Problem-based Learning into abstract material, students can deepen their understanding of science learning concepts and develop critical and analytical thinking skills to achieve learning objectives [11].

Based on the results of pre-research conducted on Class V Teachers of SD N Ngijo 01 Semarang City on September 9, 2024, several problems related to science learning were found. The main problem is the limited sources of interactive electronic-based teaching materials, resulting in low student understanding of science learning [12]. The teaching materials still use the Teacher's Guide Book and Student Book from the Ministry of Education and Culture in 2022, which is still less innovative and limited because it can only be used during class hours. Second, the cognitive learning outcomes of Class V students are low, indicating the value of science learning in Material Chapter 4 of the Earth's Surface Layers, with 66.6% of students getting a score below the Minimum Completion Criteria (KKTP), namely 70. This result is caused by students' difficulty understanding the study of abstract material in the teaching materials and the teachers' suboptimal application of the learning model because it is still teacher-centered [13].

Third, the material in Chapter 4 of the Earth's Surface Layers is abstract, has many foreign terms, is not supported by adequate visualization of the material, and has practical experience in learning materials. Based on the problems described above, the solutions provided by the researcher are as follows: First, the development of interactive e-book learning materials. Learning resources are very important during and outside of learning so that it can take place more effectively and efficiently with achievements and competencies [14]. Second, applying the Problem Based Learning model optimizes science learning. Stages in PBL syntax, such as problem orientation, independent investigation, group discussion, solution presentation, and reflection, are designed to provide an in-depth learning experience. Through this approach, students understand the concept theoretically and develop critical and analytical thinking skills in problem-solving [15].

The existence of an interactive e-book based on problem-based learning is designed to find solutions to learning problems. This study focuses on presenting material by prioritizing the syntax of problem-solving-based learning that is conveyed clearly. Visualization of the concept is done through audiovisual presentation based on learning images and videos designed by researchers, making it easier for students to understand abstract material. [16] In addition, this product is designed to provide stimulation that encourages active interaction between students, presents detailed

explanations of the material, and is equipped with interactive games that provide direct feedback [17]. To increase the enthusiasm for learning, it is accompanied by songs that function as additional stimulation for students to be more motivated to understand the material.

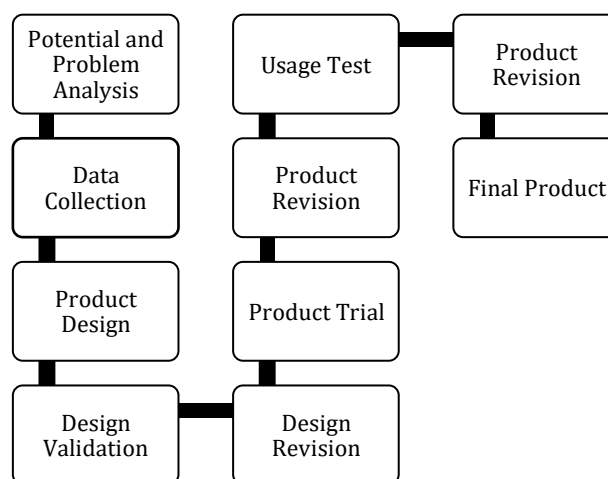
Some of the research results align with research [18], which shows that the development of E-Books based on Problem Based Learning concludes that the research is feasible and effective in improving Science learning outcomes. Research [19] shows that the research is very feasible and effective to use. The research [20] shows that it is very good and worthy of being used as additional teaching material for students.

In the previous research that has been presented, the novelty of this research lies in the development of Interactive Science Teaching Materials for Class V, especially in Chapter 4 of Topic A of the Earth's Surface Layers and Topic B of Earth's Change Factors at SD Negeri Ngijo 01, which has implemented the Independent Curriculum. In this study, there are innovations in learning syntax, such as dividing groups based on student abilities and organizing discussions, which support understanding of the material and build collaborative skills.

This research is essential to understand better the potential use of technology in learning, especially in supporting more innovative and enjoyable mastery of material for students [21]. Developing and testing this technology-based teaching material is expected to provide creative solutions to overcome the challenges faced in science learning and improve overall student learning outcomes. Based on the background description that has been presented, the study aims to describe the development design, test the feasibility, and measure the effectiveness of Interactive E-Books based on Problem-Based Learning in improving science learning outcomes in grade V students of SD N Ngijo 01, Semarang City.

### Research Method

This research uses the Research and Development (RnD) type, a development model from Borg and Gall [22]. The research and development sequence is described below.



**Figure 1.** Stages of RnD Research Using the Borg and Gall Model

Based on the image above, the researcher used a development model of only 8 steps; this is because the research conducted only went as far as testing the effectiveness of teaching materials, considering the limited time and costs in carrying out mass production of teaching materials that had been developed [23]. Researchers take the following stages; analysis of potential and problems; data collection; product design; design validation; design revision; product trial; product revision; and usage test.

The researcher took the following stages: analysis of potential and problems, data collection, product design, design validation, design revision, product trial, product revision, and usage test. The research sample consisted of 24 students in grade V of SD N Ngijo 01 Semarang City, composed of 10 males and 14 females. Data collection techniques included tests (pretest and posttest) and non-tests in the form of observation, interviews, questionnaires, and documentation. The next step was to conduct data analysis techniques to test the effectiveness of Interactive E-Books based on Problem Based Learning in the form of normality tests, t-tests, and N-Gain [24].

**Result and Discussion**

The research results from the development of Interactive E-Books based on Problem-Based Learning aim to describe the development design and test the feasibility and effectiveness of These Books to improve the science learning outcomes of Grade V Students of SD N Ngijo 01 Semarang City.

**Development of Interactive E-Book Design Based on Problem-Based Learning to Improve Science Learning Outcomes**

Based on the Borg and Gall development model, the researcher carried out the development design of an Interactive E-Book based on Problem-Based Learning in the following stages.

The First Stage is Potential and Problem Analysis. In this potential and problem analysis stage, researchers identified learning problems at SD N Ngijo 01 through teacher interviews, classroom observations, and document analysis. Some of the main problems found were limited sources of interactive teaching materials, suboptimal learning models, low cognitive learning outcomes, and a lack of visualization of abstract materials. On the other hand, the potential analysis was to identify the interactive use of mobile phones for learning and the existence of supporting facilities such as wifi and LCD. Development research was carried out to overcome learning challenges, especially in delivering abstract learning materials.

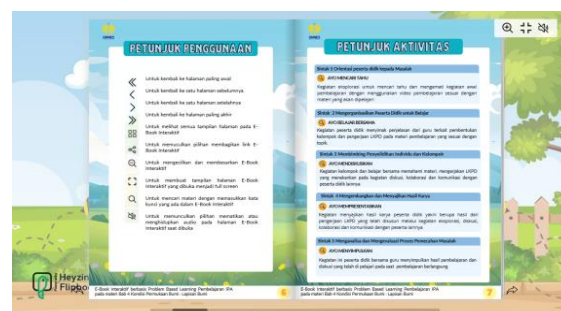
The Second Stage is Data Collection. At this stage, the researcher conducted observation activities and interviews and provided a needs questionnaire to teachers and students conducted by the researcher aimed at identifying the products needed to overcome existing problems. The results of the needs questionnaire showed that teachers and students required interactive technology-based teaching materials to improve the quality of science learning in the classroom. The desired teaching materials can attract attention through attractive visual presentations so that students can actively participate in learning [27]. The teacher

also said that teaching materials should be equipped with images that support learning concepts and learning videos that provide more precise visual explanations. In addition, the interactivity of teaching materials, such as interactive game features, helps students understand the material in a fun way and improves critical thinking skills. The third stage is Product Design. Researchers design Interactive E-Books based on Problem-Based Learning, starting with a prototype; at this stage, the aim is to design products that suit the needs of teachers and students. At this stage, researchers carry out activities to design learning devices during the learning process. The media used for designing is the Canva application. Canva helps teachers create learning materials visually and interactively. Canva provides various templates that make it easy to develop learning media, such as presentations, posters, icons, and visual images [28]. This Canva application makes the packaging of teaching materials practical and easy to use, thus increasing students' ability to understand learning materials. After designing using Canva, researchers download it in PDF format and then insert it into a flipbook to be used as an interactive e-book based on problem-based learning; then, it can be shared with students using a link.

The novelty of this research lies in the presentation of material that applies the syntax of the Problem-Based Learning model, which includes stimulus variations, grouping, presentation of results, and reflection. The model also integrates interactive elements such as images, videos, sounds, and interactive games to facilitate a more concrete understanding of the concept of the earth's surface layers [29]. The results of product development are presented in Figure 2.



**Figure 2. Home Page**



**Figure 3. Instructions for Use and Activities**



**Figure 4. Achievement Indicators and Concept Maps**





Figure 5. PBL Learning Syntax



Figure 6. Interactive Learning Video

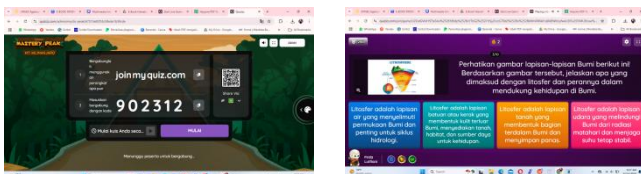


Figure 7. Interactive Edugame

The innovation in this development lies in the learning syntax, which includes stimulus variations in the first syntax. In the first and second learning, there are visual images and interactive learning videos; the integration of interactive learning videos designed and compiled independently by this researcher provides a more visual, interesting explanation and can help students to understand abstract concepts concretely. In the second syntax, there is an organization of students to learn. Namely, there are learning grouping steps that are adjusted to the level of student understanding, including high, medium, and low understanding, and there are steps for working on LKPD. In the third syntax, learning material is presented with visual images and interactive learning videos that students will discuss. In the fourth syntax, there are steps for presenting the work results. In the fifth syntax, there is a learning conclusion to help students summarize the main points of the material, interactive edugame questions to encourage students to think critically and find answers through exploration, learning reflections to evaluate how to study the material, and a glossary to help students understand scientific terms [30].

The Fourth Stage is Design Validation. Design validation is evaluating the feasibility of materials and media in the product being developed. Material expert validators assess the substance and accuracy of learning content, such as the material on the earth's surface layers, based on conceptual clarity, curriculum relevance, and student needs [31]. Meanwhile, the media expert validator evaluates the visualization, technical, and interactivity, including appearance, design, and ease of use. The validator provides suggestions for improvement if deficiencies are found to improve the quality of the product according to learning objectives.

The Fifth Stage is Design Revision. The researcher made revisions based on suggestions from the material expert validator on the learning syntax to improve the clarity and structure of the material. The first revision changed the second syntax; before the product revision, the teaching materials in the second syntax focused on the material, then after that, it contained the steps for grouping learning and working on LKPD, which were given to improve grouping in education, so that students could more easily understand the steps for learning in groups. The second revision in the third syntax, which initially only focused on working on LKPD, was expanded to include learning materials so that students could more easily connect the material with the LKPD tasks being worked on. After the revision, the learning product was ready to be tested in schools.

The Sixth Stage is Product Trial. This research was continued to the stage of providing a product trial response questionnaire to teachers and students of grade V of SD N Ngijo 01 Semarang City on a small scale or as many as 6 students, of which 2 students ranked top, 2 students ranked middle, and 2 students ranked bottom, out of 24 students of grade V. After carrying out learning using the developed teaching materials, the researcher then gave a response questionnaire to teachers and students, as further improvements before being tested for use on a large scale.

Seventh Stage Product Revision. Based on feedback from teachers and students, the researcher revised the language used and fixed elements that were difficult to understand. After the revision, the product was ready to be tested more widely.

Eighth Stage Usage Test. The revised product was tested on a large scale in class V of SD N Ngijo 01, with a total of 16 students, to test the effectiveness of the teaching materials used. Pre-tests and post-tests were carried out to measure understanding and success before and after using interactive e-books based on problem-based learning and to provide responses related to the development product. This trial aims to validate and ensure that the resulting product is feasible and effective for use in learning.

**Feasibility of Interactive E-Books Based on Problem-Based Learning to Improve Science Learning Outcomes**

The Feasibility Test was conducted by conducting product validation with material experts and media experts, aiming to assess the feasibility of the development product. The assessment was carried out by filling out the validation instrument by both validators. The results of the validation process showed that:

Table 1. Validator's Assessment of the Feasibility Aspect

Validator	Percentage %	Assessment Category
Material Expert	91.25%	Very Eligible
Media Expert	92.18%	Very Eligible

Based on Table 1, the assessment aspects given by the material expert validation include accuracy with learning objectives, suitability with the level of thinking, support for content, stimulus to help understand the material, and accuracy of learning content obtained an assessment percentage of 91.25% with a very feasible category. The assessment given by the media expert validator assessed the

aspects of content quality and objectives, construction, and technical/appearance, obtaining an assessment percentage of 92.18% with a very feasible category. Responses from material experts include adjustments to learning syntax and variations in levels of understanding that are in accordance with the Problem-Based Learning learning model so that all groups can more easily understand the material. Responses from media experts include adjustments to visual design with appropriate student characteristics to increase student involvement and attention.

Teachers and students also complete a questionnaire to assess the suitability of the material and presentation design. The results of this response are used to evaluate the feasibility and effectiveness of the development product in the learning process.

**Table 2.** Results of the Teacher and Student Response Questionnaire

Respon	Percentage%	Assessment Category
Teacher	96%	Very Eligible
Students	99.3%	Very Eligible

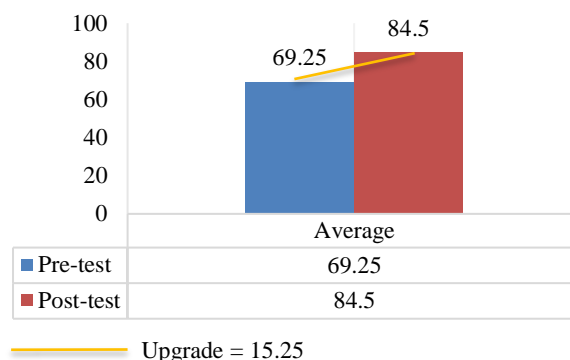
Based on Table 2, with the teacher questionnaire assessment aspects covering the suitability of the material and the suitability of the design, the student questionnaire assessment aspects covering the suitability of the material and the presentation of the design display, indicating that the results of the teacher and student response questionnaires are in the very feasible category, with a percentage of 96% from teachers and 99.3% from students. The responses from teachers and students to the first developed product, the material presented in the Interactive E-Book based on Problem-Based Learning, is very appropriate to students' learning objectives and needs, making it easier to understand abstract concepts. Second, the design and presentation of an attractive and interactive display, with the integration of images, videos, and interactive edugames can help clarify the material and increase student involvement in learning. This finding is in line with previous research showing that the validation assessment of material experts obtained a score of 87.5% and media experts 90%; the conclusion is that the teaching material is feasible and effective for learning.

**The Effectiveness of Interactive E-Books Based on Problem-Based Learning to Improve Science Learning Outcomes**

Learning effectiveness can be measured by looking at changes in cognitive learning outcomes, which are obtained by comparing pre-test and post-test scores. The effectiveness of Interactive E-Books was tested through several analyses, including normality tests, t-tests, and N-Gain tests. The average pre-test score was recorded at 69.25, while the average post-test score increased to 84.5, indicating an average increase of 15.25.

Based on Figure 7, the data collected by the researcher includes the pre-test and post-test results, which were then analyzed using a normality test. The analysis carried out on the pre-test and post-test data was to determine whether the data followed a normal distribution. The decision-making criteria in the normality test are if the significance value (sig) is more significant than (0.05), then

the data is usually distributed; conversely, if the significance value is less than (0.05), the data is not normally distributed.



**Figure 7.** Average Results of Pre-test and Post-test of Grade V Students of SD N Ngijo 01, Semarang City

**Table 3.** Results of Pre-test and Post-test Normality Tests

Action	N	Mean	Sig.	Category
Pre-test	24	69.25	0.174	Normal
Post-test	24	84.5	0.151	Normal

Based on Table 3, the significance value (Sig.) for the pre-test and post-test data is greater than (0.05), it can be concluded that the sample distribution is normal. After the pre-test and post-test, data can be stated to be normally distributed through the normality test, and the next step is to carry out the t-test. This test uses parametric statistical techniques to analyze the average difference between the pre-test and post-test values.

**Table 4.** Pre-test and Post-test t-test

Action	N	Mean	T	Sig. (2- tailed)
Pre-test	24	69.25	-10.315	0.001
Post-test	24	84.5		

Based on Table 4, there is a difference in the results of the average value test. The t-count value obtained is -10.315. With a sample size of 24, the t-table value used is 2.064 or -2.064. The t-test results showed that  $-tcount < -ttable$ , namely  $(-10.315 < -2.064)$ , then  $H_a$  is accepted, and  $H_0$  is rejected. This shows that the development has been successful, is very feasible, and is effective in science learning to improve student learning outcomes. Based on the results of the t-test calculation, it can be concluded that there is a significant difference between learning outcomes before and after using Interactive E-Books based on Problem Based Learning as teaching materials. The last test in this study was the N-Gain test to determine and measure the extent to which cognitive learning outcomes increased. The average increase in learning outcomes was analyzed through the N-Gain test to see the effectiveness of the development.

**Table 5.** N-Gain Test Results

Action	Diferent	N-Gain	Criteria
Pre-test	15.25	0.50	Currently
Post-test			

Based on the table, it can be seen that there is an average increase (N-Gain) between the pre-test and post-test

data of 0.50, which is included in the moderate category, with an increase in student learning outcomes of 15.25. The increase obtained from the average learning outcomes is in the moderate category. At the same time, the developed product received a very decent assessment from material and media experts and positive responses from teachers and students. In the moderate (N-Gain) category, it is caused by several factors, namely student readiness and learning style. Students with good digital literacy find it easier to access and utilize interactive features, such as images and videos, to understand the material. Different learning styles also affect learning success. Interactive teaching materials require time to adapt, especially for students who are less familiar with technology. This is in line with previous research [18], which shows that although the use of E-Books based on Problem Based Learning can improve learning outcomes, factors such as digital literacy and adaptation time are key to the success of its implementation. This is in accordance with previous research. Research [19] This research implies that Interactive E-Books can increase students' motivation and interest. The research is supported by [32] explaining that the Problem Based Learning learning model is effective in improving science learning outcomes. Based on data analysis, it can be concluded that using Interactive E-Books based on Problem Based Learning is feasible and effective as a learning resource [33].

## Conclusion

The development of an Interactive E-Book based on Problem Based Learning on the Earth's Surface Layer material using the Borg and Gall Research and Development (RnD) model was successfully developed with a very feasible category from material experts, media, and the results of the questionnaire responses from teachers and students. This study shows a moderate N-Gain (0.50), which indicates an increase in student understanding, although there is still room for optimization. So, the Interactive E-Book based on Problem-Based Learning was successfully developed, was very feasible, and improved the science learning outcomes of grade V students in Chapter 4 of the Earth's Surface Layer Material.

## Author Contribution

This research article was published thanks to the collaboration of the first author, Firda Dian Lutfiani, and the second author, Aldina Eka Andriani. The authors' contributions include creating learning media and tools, conducting research, analyzing data, and compiling the manuscript. All authors have reviewed and approved the final version of the article.

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