Development of a STEAM-Based E-Module Flipbook for Elementary Science Education on Electricity Topics

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Abstract
The lack of variation in science teaching materials has an impact on students' interest in learning, thus affecting the learning outcomes of electricity material. This study aims to produce a valid and practical STEAM-based flipbook e-module on electricity material for grade V of elementary school. The object to be studied is STEAM-based e-module teaching materials while the subjects of this study are grade V students of SDN Purworejo. This study uses the Research and Development (R&D) method with the ADDIE development model. The results of the e-module flipbook feasibility test based on content experts were 90.25% with very good qualifications, language experts were 89.60% with very good qualifications, learning media experts were 88.20% with very good qualifications, individual trial results were 90.00% with very good qualifications, small group trial results were 92.80% with very good qualifications and field trial results were 89.50% with very good qualifications. So, the STEAM-based flipbook e-module is effective in improving the learning outcomes of the electrical science subject of grade V and is included in the very valid and very practical categories.
Keywords: *Flipbook E-Module, STEAM, Electricity, Elementary School*

Abstrak
Penggunaan bahan ajar pada mata pelajaran IPAS di Sekolah Dasar yang belum bervariasi sehingga berdampak pada proses pembelajaran yang kurang menarik perhatian peserta didik khususnya pada materi listrik. Penelitian ini mempunyai tujuan untuk menghasilkan *e*-modul *flipbook* berbasis STEAM pada materi listrik kelas V Sekolah Dasar yang valid dan praktis. Objek yang akan diteliti yaitu bahan ajar *e*-Modul bebasis STEAM sedangkan subjek penelitian ini adalah peserta didik kelas V SDN Purworejo. Penelitian ini menggunakan metode *Research and Development (R&D)* dengan model pengembangan ADDIE. Hasil uji kelayakan e-modul *flipbook* berdasarkan hasil review ahli isi mata pelajaran sebesar 90,25% dengan kualifikasi sangat baik, hasil review ahli bahasa sebesar 89,60% dengan kualifikasi sangat baik, hasil review ahli media pembelajaran sebesar 88,20% dengan kualifikasi sangat baik, hasil uji coba perorangan sebesar 90,00% dengan kualifikasi sangat baik, hasil uji coba kelompok kecil sebesar 92.80% dengan kualifikasi sangat baik dan hasil uji coba lapangan sebesar 89,50% dengan kualifikasi sangat baik. Jadi, e-modul *flipbook* berbasis STEAM efektif meningkatkan hasil belajar IPAS materi listrik kelas V dan termasuk kedalam kategori sangat valid dan sangat praktis.
Kata kunci: *E*-Modul *Flipbook,* STEAM, Listrik, Sekolah Dasar

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INTRODUCTION

Education is one of the most important factors in determining the quality of human resources and the progress of a nation. In line with researchers Ferdiansyah, Haling, & Nurhikmah (2021) who explained that education is very important for both developed and developing countries, because it plays an important role in improving the nation and state. Munandar (2017) said that the education process is able to produce creative, innovative ideas in the dynamics of the development of the times. Curriculum development is an instrument to improve the quality of education.

The curriculum in Indonesia has undergone several changes, because along with the times and the adjustment of the characteristics of the development of students which have continued to develop from time to time. Sholekah (2020) said that these changes were made of course to improve the existing education system so that the most effective system was found to achieve national education goals. Teachers' understanding of the curriculum used in learning is also a determining factor in achieving better education quality (Maryati, 2020).

The Independent Curriculum provides teachers with the opportunity to design learning materials and determine learning methods that are appropriate to the abilities, talents, and interests of students (Oksari et al., 2022). Currently, Indonesia is implementing the Independent Curriculum and the characteristic of this Curriculum is the integration of Natural Sciences (IPA) and Social Sciences (IPS) into Natural and Social Sciences (IPAS) at the elementary school level. The need for science learning to be instilled from elementary school level to the next level (Yunanto & Ninawati, 2022).

This is in line with Purnawanto (2022) who stated that elementary school students are still in the stage of concrete/simple, holistic and comprehensive thinking but not detailed. Science learning in elementary schools is expected to increase the relevance of learning materials to everyday real life and improve mastery of 21st century skills such as critical thinking, communication skills, collaboration skills and problem-solving skills (Fitri et al., 2023). From this opinion, students can achieve thinking skills and foster a sense of responsibility towards their environment in one unit.

The challenges of the independent curriculum are that learning facilities are still lacking, and learning resources are incomplete, while one of the goals of implementing the Independent Curriculum is to train soft skills in students through various school and learning activities (Angga et al., 2022). One way to train soft skills in class is to use the science, technology, engineering, art, and mathematics (STEAM) approach. STEAM is a learning approach that provides students with the opportunity to expand their knowledge in developing the skills needed to thrive in the 21st century such as communication skills, critical thinking skills, leadership, teamwork, creativity, resilience, and other skills (Fatmah, 2021).

However, the phenomenon that we often encounter in the field is the low motivation of students to learn science and natural sciences material. Based on observations made by researchers in class V of Purworejo State Elementary School, Boyolali, one of the factors that causes students to lack motivation to learn science and natural sciences, especially electricity material, is that the source of teaching materials used by teachers is less interactive. The teaching materials used by teachers so far have only been printed books containing a collection of materials with pages filled with full writing, supporting books LKS are also too concise so that students get bored quickly when they have to read and study the learning. Lack of questions related to everyday life and the learning practice process.

Through the analysis of teacher needs, it is known that there is a need for innovation in teaching materials applied during learning activities. So that learning becomes meaningful and abstract material is easy for students to understand. More interactive teaching materials become an attraction and motivation for learning for students. The development of interactive and communicative teaching materials, for

example in the form of electronic books or interactive e-modules to increase student motivation and help develop students' critical thinking skills.

Based on these problems, it shows that in learning science on electricity material, teaching materials in the form of modules are needed. Flipbook e-module teaching materials are expected to improve the quality of students' learning process. This condition encourages researchers to conduct research in the form of flipbook e-modules. Teaching materials are learning tools used by teachers to facilitate learning activities in the classroom which are used as learning resources (Ciptaningtyas et al., 2022). To design teaching materials that suit the needs of students, teachers must be innovative and creative in developing interactive teaching tools (Martatiyana et al., 2023).

An alternative that teachers can make is the provision of teaching materials that were originally in printed form replaced with teaching materials made in digital form. Digital teaching materials that are developed in order to foster students' learning motivation in learning are electronic books or e-modules. E-modules are one of the non-printed teaching materials that can be developed by teachers because e-books can help provide interesting, effective, and efficient learning experiences.

E-modules are electronic media that are easy to use because they include links to make students interested and motivated in understanding the material (Qolbuani, Tahir, & Rosyidah, 2022). This is in line with (Irwansyah et al., 2017) that the visualization of content in e-modules is generally presented in the form of videos or animations with text or images with text. The use of this visualization aims to make users understand the content presented in the e-module. The presentation of learning materials in electronic form will certainly be more interesting and provide various conveniences.

One of the applications used to create e-modules is flipbook. Flipbook is a digital book that when opened the next page seems to be able to move. According to Cholifah & Muslihasari (2022) flipbook is an interesting and not boring media because it is an interactive media that contains video, audio, and other links. So, it can be concluded that the flipbook e-module media is an innovative electronic media in the form of a user-friendly digital book, if opened it seems to be able to move and the links in it can be accessed so that it can be said that the media is interactive media.

Developing E-Module teaching materials based on Flipbook is one way to make classes interesting. In the study (Arnila et al., 2021; Ly et al., 2024) it was stated that students can understand the material more easily by using flipbooks in E-Modules. Digital flipbooks are one type of learning media that can help learning (Haryati et al., 2023). Digital flipbooks present independent learning materials that are systematically arranged into the smallest learning units so that they can achieve certain learning objectives. In addition, it has navigation and multimedia elements, which make users more interactive with the media, especially science learning with electricity material in grade V of Elementary School.

Good learning outcomes are a provision and determination of the success of a good and quality learning process, so that it becomes a reflection of pedagogy and practice for the future (Møller-Skau & Lindstøl, 2022). Data on learning outcomes is very important for tracking progress in achieving educational goals, understanding what educational policies are successful (and unsuccessful) (Johnson & Parrado, 2021). Evaluation of the independent curriculum in addition to looking at student learning outcomes, namely looking at science process skills as the first step in student skills in investigating problems in their surroundings.

If the STEAM-based flipbook e-module is used as a teaching material, it will have many advantages. The advantage is that the electrical material can be delivered in a user friendly and interactive way, students will feel motivated and not bored, and it is useful for basic skills in the 21st century where students not only understand the

theory but also practice it directly by conducting experiments or research. In line with the opinion of Angeli & Christoforou (2019) that if the STEAM approach is implemented, it can increase curiosity and motivate students in learning science and technology. The purpose of this study was to find out the validity, practicality, and effectiveness of the flipbook e-module on STEAM-based electrical material in grade V Elementary School.

METHOD

The type of research in this study uses the Research and Development (R&D) method with the ADDIE model. This model is also a learning approach that focuses on individual learning, direct and continuous stages and systematic with a systems approach to human knowledge and learning (Hidayat, 2021). The research and development method or commonly called Research and Development (R&D) is a scientific research method that develops a product, either a new product or an existing product, then tests the product, one of which is in product research in the form of a STEAM-based flipbook e-module media. This is in line with the opinion of Sulasmiwati, Astuti & Wicaksono (2022) that the R&D method is also a research method that produces innovative products that develop new or existing products, to make them more attractive, which depends on the learning objectives of a particular main idea.

The ADDIE model can be used in product development in the form of textbooks, learning videos, learning modules, multimedia, and so on (Tegeh, Jampel and Pudjawan, 2014). There are five steps in the ADDIE stages, namely analysis, design, development, implementation, evaluation in accordance with Winatha's opinion that the ADDIE model consists of five steps, namely analysis, design, development, implementation and evaluation (Winatha, et al., 2018). This research and development used test subjects, namely upper-class students, namely class V of Purworejo State Elementary School. In this study, product trials were carried out in 2 stages. This research was conducted in semester 2 starting from September - December.

The first stage is a product trial by experts including 1 subject matter expert, 1 language expert and 1 learning media expert. The second stage was carried out by product trials by trial subjects which were carried out in 3 stages, namely individual trials involving 3 fifth grade elementary school students who were students with low, medium, and high levels of learning achievement. Small group trials were carried out by product trials involving 9 fifth grade elementary school students consisting of 3 students with high learning achievement, 3 students with medium learning achievement and 3 students with low learning achievement. In the field trial stage, a trial of the developed product was carried out involving all fifth grade elementary school students of Purworejo totaling 18 students.

After the product was declared feasible, an effectiveness test was conducted to determine the effectiveness of the developed STEAM-based flipbook e-module. The effectiveness test was conducted by comparing the results of the pre-test and post-test given to grade V students of Purworejo State Elementary School. Data collection for this study used test and non-test methods. The test method used was an objective test to determine student learning outcomes. The non-test method used was an unstructured interview, observation, and questionnaire.

Unstructured interviews were conducted to collect data related to problems in the field and the need for STEAM-based e-modules in Chapter 3 of the electricity material of the independent curriculum for grade V of Purworejo State Elementary School. Observations were conducted to determine the condition of the school environment. The questionnaire was used to obtain data from review results from subject matter content experts, learning media experts, language experts and to measure the feasibility of the e-module during individual trials, small group trials, and

field trials. The data collection instruments used in this study were in the form of questionnaire sheets and objective or multiple-choice test questions.

The questionnaire sheet was used to collect data from review results from subject matter content experts, learning media experts, language experts. In addition, it is used to collect student assessment results during individual trials, small group trials, and field trials. Objective test questions are used to measure student knowledge before and after using STEAM-based flipbook e-module products. Before use, the instrument is tested first.

Instrument trials are carried out so that the instruments used are suitable for collecting data. The test instrument that will be used to measure student learning outcomes must meet several requirements including the validity of test items, discrimination power, level of difficulty and test reliability. The data analysis techniques used in this development research are qualitative descriptive analysis, quantitative descriptive analysis, and inferential statistical analysis.

Qualitative descriptive analysis is used to process data from the review results of learning content experts, language experts, learning media experts and product trials to students by grouping information from qualitative data in the form of suggestions or input, responses, criticisms, and suggestions for improvement contained in the questionnaire and interview results. After analyzing the data, the results of the data analysis are then used as a reference in revising the developed product. Quantitative descriptive analysis techniques are used to process data obtained through questionnaires or surveys using a Likert scale with a scale of 4 with scoring for positive statements, namely agree (SS) = 4, agree (S) = 3, disagree (TS) = 2, and strongly disagree (STS) = 1. Conversely, negative statements with strongly agree (SS) answers are given a score of 1. The scores that have been obtained will be converted into percentages from each subject.

In this study, inferential statistical analysis was used to determine the level of product effectiveness on student learning outcomes after being given a STEAM-based flipbook e-module product in learning. Field trial data were collected by providing a pre-test and post-test, namely the IPAS content in Chapter 3 of the electricity material of the independent curriculum. The results of the pre-test and post-test were then analyzed using a dependent sample t-test to determine the difference between the pre-test and post-test results. The analysis technique used for hypothesis testing in this study is the dependent sample t-test analysis technique. The basis for using the dependent sample t-test technique is because this study carried out two measurements or two treatments on one sample group, namely before and after using the STEAM-based flipbook e-module.

RESULT AND DISCUSSION

The STEAM-based flipbook e-module developed with the ADDIE model has five stages, namely the analysis stage (analyze), design (design), development (development), implementation (implementation), and evaluation (evaluation). The first stage is the analysis stage (analyze). At this analysis stage, an analysis of initial conditions, analysis of field needs and analysis of initial competency mapping and indicators and learning objectives are carried out, in order to get an overview and at the same time the results of the analysis are used as guidelines in product development to suit the needs in the field.

Based on the results of the initial analysis, it is known that in the learning process, teachers use very little teaching materials in the form of e-modules, they are accustomed to using printed media teaching materials for teachers and students from the government, the use of e-modules in the learning process is not optimal. The teaching materials used by teachers are taken from supporting books or LKS books. The teaching materials used are only in the form of questions that must be worked on

by students. The teaching materials are not interesting and not interactive. Students do not get quick feedback and scores related to the books or LKS that are worked on. Based on the analysis of field needs and mapping of initial competencies and indicators, it is known that the content of the IPAS Chapter 3 electricity material requires learning media in the form of innovative and interactive e-modules.

The second stage is the design stage. At this stage, several activities are carried out, namely (1) Data collection, in the form of data needed at the product development stage, namely text, images, button icons and material content on the product and the software used. (2) Making a storyboard.

The third stage is the development stage. At this stage, product development is carried out according to the predetermined design. Activities at this development stage include (1) Making a product screen display using the Canva application, (2) Adding material content using Canva, (3) Adding tasks/activities to the e-module using the Canva application (4) changing the design of the Canva e-module with a Heyzine flipbook which will later be connected to the HTML address publish online so that the product can be accessed via a link, (4) Accessing the developed e-module link, (5) Making a product review questionnaire for experts, (7) Making a product trial questionnaire for students (9) Product validation by the validator.

The fourth stage is the implementation stage. At this stage, the product that is suitable for use directly in the learning process. Before giving the product, students are given a pre-test to determine the initial knowledge of students, after which the product can be used. The next stage is giving a post-test to determine whether there is a difference in learning outcomes before and after using the STEAM-based flipbook e-module.

Tabel 1. Presentase Kelayakan Produk Berdasarkan Subjek Uji Coba

No	Subjek Uji Coba	Hasil Validitas	Keterangan
1	Uji Ahli Materi Mata Pelajaran	90,25%	Sangat Baik
2	Uji Ahli Bahasa	89,60%	Sangat Baik
3	Uji Ahli Media Pembelajaran	88,20%	Sangat Baik
4	Uji Coba Perorangan	90,00%	Sangat Baik
5	Uji Coba Kelompok Kecil	92.80%	Sangat Baik
6	Uji Coba Lapangan	89,50%	Sangat Baik

The fifth stage is the evaluation stage. The evaluations carried out are formative and summative evaluations. Formative evaluations are carried out to assess the products developed including expert validation, individual trials, small group trials, and field trials to be used as a reference in improving the products developed. Summative evaluations are carried out to determine the effectiveness of the products developed by conducting analysis using dependent sample t-tests. In formative evaluations, expert validation is carried out. The scores obtained are based on expert reviews and product trials by trial subjects presented in Table 1.

Based on the results of the review and trial results of the interactive STEAM-based LKPD, the validity of the content aspect obtained a percentage of 90.25% in the very good category. This is in line with research conducted by (Oktaviara & Pahlevi, 2019), which found that the validation of material experts on the e-modules they developed reached 90% and was included in the very valid category. Research conducted by (Susanti et al., 2023) also found the same results, with the evaluation of material experts from the developed e-modules reaching 95.8%, and was included in the very good category.

The validity of the language aspect obtained a percentage of 89.60% in the very good category, and the media aspect obtained a percentage of 88.20% in the very good category. This research is in line with the results of research (Lestari & Apsari, 2022), which showed that the e-modules they developed obtained valid results. Research (Humairah et al., 2022) also showed the same results, where the e-module they developed scored 88% and was categorized as very valid by experts.

The results of the product trial at the individual test stage obtained a percentage of 90.00% in the very good category, the results of the small group trial obtained a percentage of 92.80% in the very good category and the field trial obtained a percentage of 89.50% in the very good category. This indicates that the STEAM-based flipbook e-module developed is suitable for use in the learning process with very good qualifications.

The effectiveness of the STEAM-based flipbook e-module was carried out by giving an objective test to 18 fifth grade students. Objective test questions were used to collect data on student learning outcomes before and after using the STEAM-based flipbook e-module. Before implementing the STEAM-based flipbook e-module, 18 fifth grade students were given a pre-test, then the product was applied in the learning process and continued by giving a post-test. The average pre-test score of students was 65 and the post-test score of students was 79.

Based on the pre-test and post-test values, a normality test was carried out as a prerequisite for the dependent sample t-test. The results of the pre-test normality test obtained X^2 count = 7.480 <X^2 table = 11.0705, then Ho is accepted. So it can be concluded that the sample comes from a normally distributed population. While the results of the post-test normality test obtained $X^2\ hitung$ = 8.38021 <X^2 table = 11.0705, then H_0 is accepted. So it can be concluded that the sample comes from a normally distributed population. Based on the results of the normality test, it was obtained that the data was normally distributed. Furthermore, a hypothesis test was carried out using the dependent sample t-test formula.

Furthermore, a hypothesis test was carried out using the dependent sample t-test formula. Based on the results of the t-test, tcount = −3 with db = n−1 = 25−1 = 24, ttable significance 5% = 1.711, it can be seen that tcount> ttable, so H0 is rejected H1 is accepted. This means that there is a significant difference (5%) in the learning outcomes of Chapter 3 of electrical material for class V using the STEAM-based flipbook e-module. So it can be interpreted that the STEAM-based flipbook e-module is effective in improving the learning outcomes of Chapter 3 of electrical material.

Based on the results of the review of the STEAM-based interactive LKPD subject content experts, it is stated that it is suitable for use in the learning process with very good qualifications, based on the suitability of the electrical material for class V, the suitability between the material and the initial competencies of the indicators and the objectives to be achieved in learning. The results of the validity of the learning design expert are qualified as good and the results of the validity of the learning media expert are qualified as very good.

The results of the product trial at the individual test stage involving 3 students are qualified as very good, the results of the small group trial involving 9 students are qualified as very good and the results of the field trial are qualified as very good. There is a significant difference (5%) in the learning outcomes of the IPS content of Chapter 3

of electrical material for class V using the STEAM-based flipbook e-module. So that the STEAM-based flipbook e-module is effective in improving the learning outcomes of the IPS content of Chapter 3 of electrical material.

The developed STEAM-based flipbook e-module can provide a more attractive e-module display and can display feedback and scores quickly related to student work results, thereby building student enthusiasm in following the learning process. This is relevant to previous research, namely research by Aldila et al., (2017), regarding the development of STEM-based LKPD to foster students' creative thinking skills. The research produced a product in the form of STEM-based LKPD to foster students' creative thinking skills on the material of Elasticity and Hooke's Law.

CONCLUSION

Based on the results of data analysis and discussion that have been presented, it can be concluded that the design of the STEAM-based flipbook e-module follows the stages of the ADDIE development model which has five stages, namely the analysis stage, design stage, development stage, implementation stage, and evaluation stage. Based on the results of the review of the STEAM-based flipbook e-module subject matter experts, it was declared feasible to be used in the learning process with very good qualifications, the results of the language expert's validity were very good and the results of the learning media expert were very good.

The results of the product trial at the individual test stage were very good, the results of the small group trial were very good and the results of the field trial were good. There was a significant difference (5%) in the learning outcomes of the IPS content Chapter 3 of the electricity material for class V using the STEAM-based flipbook e-module. So that the STEAM-based flipbook e-module is effective in improving the learning outcomes of the IPS content Chapter 3 of the electricity material for class V students and is included in the very valid and very practical categories.

The implications of this E-module are able to attract children's attention so that they learn from other sources that are more varied than the material. It is equipped with questions and answers and quizzes that can hone their knowledge, can express a simple electrical circuit correctly and can create a poster work about electricity. From the explanation above, teachers or parents are expected to be able to accompany or review the material that has been learned through this E-Module. For other researchers, it is hoped that they can further develop this STEAM-based flipbook e-module product.

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