

Development of Electronic Books Using Website 2 APK Builder Pro Based on Science, Technology, Engineering, and Mathematics (STEM) to Improve Learning Outcomes

Chercules¹, Ismet¹, Ida Sriyanti^{1*}

¹ Master of Physics Education, Faculty of Teacher Training and Education, University of Sriwijaya, Palembang, Indonesia.

Received: September 3, 2023

Revised: October 9, 2023

Accepted: November 25, 2023

Published: November 30, 2023

Corresponding Author:

Ida Sriyanti

ida_sriyanti@unsri.ac.id

DOI: [10.29303/jppipa.v9i11.5182](https://doi.org/10.29303/jppipa.v9i11.5182)

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Abstract: Development of a science, technology, engineering, and mathematics (STEM)-based climate change electronic book aided by the APK Builder Pro website to improve learning outcomes. This study aims to determine the validity, practicality, and effectiveness of the product to improve learning outcomes. This research aims to produce an Electronic Book Using Website 2 APK Builder Pro based on Science, Technology, Engineering, and Mathematics (STEM). Product development is based on students' needs for 21st century learning with the industrial technology revolution 4.0 which is identical to the utilization of technology, information, and communication. The method used in this research is research and development (R&D) with the ADDIE model development design consisting of five stages, namely analysis, design, development, implementation, and evaluation. The results of this study indicate that the percentage of validity of the Science, Technology, Engineering, and Mathematics (STEM)-based climate change electronic book averaged 86.7% with very valid criteria, the percentage of product practicality averaged a one to one test of 86.2%, a small group test of 83%, and a response from a physics teacher of 91% with very practical criteria, and the N-gain test tested on 32 students obtained an average result of 0.8 with high percentage criteria with very effective criteria. Therefore, it can be concluded that the electronic book of climate change based on Science, Technology, Engineering, and Mathematics (STEM) assisted by the APK Builder Pro website is valid, practical and effective to improve student learning outcomes.

Keywords: E-books; Perubahan iklim; STEM; Website 2 APK builder pro

Introduction

The advancement of science and communication technology information is one of the great encouragement to improve education. The use of technology in learning has an important role for technology to reach access to information and data for the needs of educators and students. Mastery of technology is an important thing that must be mastered in revolution 4.0 (Almuharomah et al., 2019). (Chercules et al. (2021) wrote that the development of technological advances will have an impact on the increasing needs of students.

Revolution 4.0 provides training for educators to be able and wise to understand the use of digital technology, means of communication and access and manage so that students enjoy learning media (Mubarok et al., 2022). The development of technological advances today makes it very easy to learn. Technology that can be utilized by education is by utilizing learning media.

Media is one of the determinants of student learning success (Chania et al., 2020). Strategies in physics learning that can be used by educators as a learning medium are using teaching materials. Teaching materials in schools, used by students to follow the learning process in the classroom and outside the classroom, students experience boredom and boredom

How to Cite:

Chercules, Ismet, & Sriyanti, I. (2023). Development of Electronic Books Using Website 2 APK Builder Pro Based on Science, Technology, Engineering, and Mathematics (STEM) to Improve Learning Outcomes. *Jurnal Penelitian Pendidikan IPA*, 9(11), 9381-9390. <https://doi.org/10.29303/jppipa.v9i11.5182>

when reading so that the educational process becomes inefficient and ineffective (Telaumbanua et al., 2021). One of the teaching materials that is in accordance with technological advances is electronic books according to the results of the analysis of the needs of students that have been carried out by researchers. Teaching materials of the electronic book type at this time are not new, but the use and methods in learning are still not widespread so that creative and innovative ideas are not renewed. The benefits of using electronic books are easy to use, easy to access, and very interesting. Students do not need to bring printed books to study, just use a smartphone, this makes it easy to learn anywhere, coupled with explanations, colors, videos, and audio, electronic books used on smartphones are very much in demand by students (Cahya et al., 2022). While physics textbooks still have many weaknesses, namely, printed books are easily damaged, monotonous, there is no video and audio in teaching materials, causing boredom in learning.

Electronic books are one of the strategies of alternative problem solving in education in order to keep up with technological advances. Electronic book development must be adapted to the current curriculum so that learning is more interesting, effective and efficient, and learning objectives can be achieved (Wati et al., 2020). With this media, learning is more interesting and more motivated. Electronic books also have the advantage of reducing the use of paper and making it more environmentally friendly (Simanjuntak et al., 2019). The focus of the e-book material in this research is climate change.

Climate change is one of the most important global environmental issues facing the world community today (Khoirunisa, 2017). As climate change impacts become more severe, adaptation may need to be more transformational than incremental, with responses that go beyond business as usual or incremental changes to activities that alter fundamental attributes of socio-ecological systems (Berrang-Ford et al., 2021). The impact of extreme events on people and the planet arises not only from climate phenomena but also the sensitivity of the biophysical environment (Holden et al., 2022). It is expected that with the above issues that have been obtained information from the results of technology students can increase knowledge and information about global issues. Learners are directly involved in how to overcome and increase awareness of the environment which is increasingly damaged. This usefulness will help education in achieving learning objectives that utilize technology so that the world of education can keep pace with technology which is now increasingly advanced. It is not only technology that is utilized, therefore the learning approach also needs to be

adjusted so that the technology used in learning is very suitable in the learning process.

The application of electronic book media learning using the website 2 APK builder pro using the STEM base is a form of educator strategy to increase student motivation and how to learn STEM learning with climate change material. STEM-based electronic books are very suitable for collaboration with climate change material. By learning to use STEM-based climate change electronic books, students learn about science, engineering, technology, and math to become problem solvers, innovators, creators, and collaborators and continue to fill the critical path of engineers, and scientists who are important for the future (Ngadinem, 2022). By connecting science, technology, engineering, and mathematics (STEM)-based e-books using proprietary smartphones, digital technology can be developed (Pramadanti et al., 2021).

From the results of the needs analysis, students are expected from this research to improve the learning outcomes of students who have been left behind. To achieve maximum learning outcomes, the right learning process is needed, this is commonly called learning. (Amaliyah et al., 2023). Research result Lasriani et al. (2023) In the needs analysis of students, the problem faced is that the media at school only uses printed books and lecture methods and media that are not varied and monotonous in the learning process, so students are not motivated to improve their learning outcomes. Learning designed by educators with creative and innovative strategies as described in the problem above regarding the development of electronic books using the website 2 APK builder pro based on science, technology, engineering, implementation, and evaluation can improve good learning outcomes with climate change material.

The goal of producing valid, practical, and effective electronic books in this study will be achieved if the results of product needs are high and vice versa if the need for electronic books is low then this product will not be developed. The first step in developing learning is needs analysis (Rayanto et al., 2020). The results of the needs analysis of electronic books using the website 2 APK builder pro based on science, technology, engineering, and mathematics (STEM) to improve learning outcomes carried out in secondary schools, the results of interviews with educators and students found that there was not much access to technology in learning due to certain limitations. Students still do not know the sophistication of technology, the global issue of climate change, and STEM-based learning. So, from these results the product developed by the researcher becomes one of the important parts to solve educational problems.

Previous research conducted by (Rizaldi et al., 2022) development of STEM-based optical devices electronic module using flip PDF professional and research application (Cahya et al., 2022) development of STEM-based electronic book teaching materials in improving science literacy skills in schools that produce valid, practical, and effective electronic teaching materials. The same thing was done in this study with the problem of how to develop electronic books using the website 2 APK builder pro based on science, technology, engineering, and mathematics (STEM) to improve valid, practical and effective learning outcomes.

Method

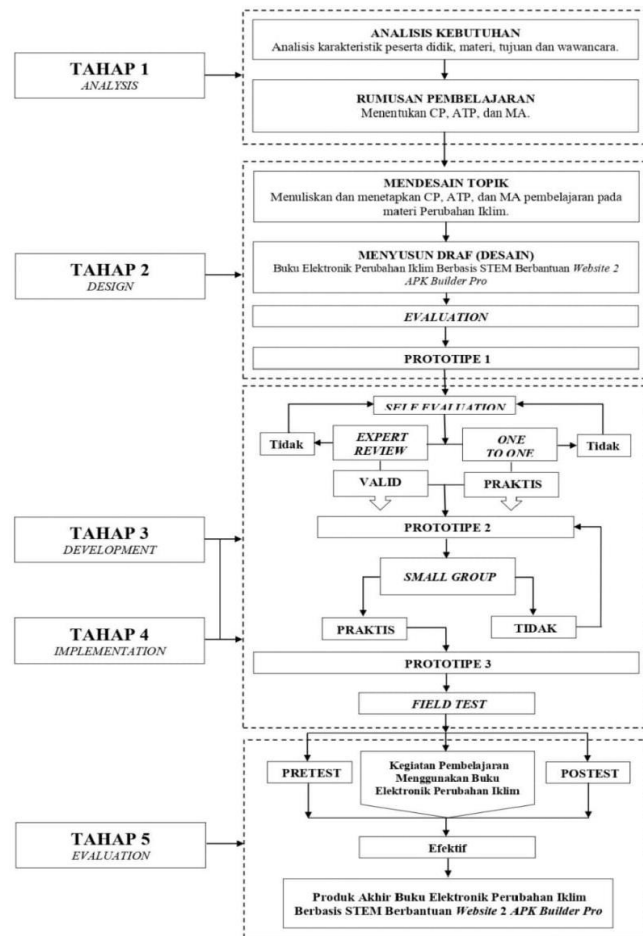


Figure 1. The research flow of the science, technology, engineering, and math (STEM)-based climate change e-book with website assistance 2 APK builder pro

The method used in this research is development research by producing products that are tested for effectiveness (Sugiyono, 2017). The resulting product is an electronic book-type teaching material using the website 2 APK builder pro based on Science, Technology, Engineering, and Mathematics (STEM) assisted by the website 2 APK builder. The subject of this research was conducted at SMA Negeri 3 Banyuasin 1

which is located on Jln. Belitung, Merah Mata Village, Kec. Banyuasin 1, Kab. Banyuasin, Prov. South Sumatra 30139. South Sumatra 30139. The product development process in this study uses the analysis, design, development, implementation, and evaluation (ADDIE) model development. The ADDIE model is a learning design model based on an effective and efficient system approach, and the process is interactive between teachers, students and the environment (Nurhikmah et al., 2023). The ADDIE development model is widely used by researchers in developing teaching materials, such as modules, LKS, and textbooks (Zulkarnaini et al., 2022). In the ADDIE development model, there are five stages, namely, analysis, design, development, implementation, and evaluation. Researchers in carrying out each stage always conduct self-evaluation at each stage in the development of climate change electronic books based on Science, Technology, Engineering, and Mathematics (STEM) based on the website 2 APK builder pro with the ADDIE development model, namely, Analysis, Design, Development, Implementation, and Evaluation. The stages of the research flow can be seen in Figure 1.

The data analysis techniques used by researchers are interviews, walkthroughs, questionnaires, and tests. Interviews are used for the initial needs of research on the problems of the teaching and learning process. While the walkthrough is used to determine the validity of the product developed by involving experts who include content aspects, media aspects, and language aspects. The results of the data analysis of the validity of the products assessed by the validators were calculated by averaging the scores using the formula, intervals and criteria in table 1 as follows:

$$X = \frac{\sum(\text{Score} \times \text{Number of Respon}) \times 100\%}{n \times \text{the highest score}} \quad (1)$$

Description:

X = Percentage of validity

Table 1. Product Validation Criterion (Razak et al., 2023)

Interval	Criteria
85% ≤ x ≤ 100%	Very valid
70% ≤ x < 85%	Valid
55% ≤ x < 70%	Simply valid
40% ≤ x < 55%	Less valid
0% ≤ x < 40%	Invalid

Furthermore, the questionnaire is used as a response to educators and students in the one to one and small group tests. The practicality of the product must be tested on educators and students. At this stage to find out the results of data analysis on the practicality of the product using the formula, percentage and criteria of table 2 as follows:

$$P = \frac{f}{N} \times 100\% \tag{2}$$

Description:

P = Final grade

F = Score gain

N = maximum score

Table 2. Criteria for Product Practicality in One to One and Small Group Tests (Chercules et al., 2021)

Percentage	Criteria
86% - 100%	very practical
66% - 85%	practical
51% - 65%	practical enough
0% - 50%	not practical

After that, the last instrument, namely, using a test instrument as the final product assessment to test the effectiveness of the product at the field test stage, the results of the N-gain value can be seen using table 3 as follows.

$$Normalized\ gain < g > = \frac{post\ test\ score - pre\ test\ score}{maximum\ score - pre\ test\ score} \tag{3}$$

Table 3. N-gain Score Categories in Product Effectiveness (Ritonga et al., 2022)

Limitations	Categori
$g > 0.7$	High
$0.3 \leq g \leq 0.7$	Medium
$g < 0.3$	Low

Result and Discussion

The results of research on the development of electronic books using the website 2 APK builder pro based on Science, Technology, Engineering, and Mathematics (STEM) to improve learning outcomes are obtained through five stages, namely the analysis stage, design stage, development stage, implementation stage, and evaluation stage which can be explained as follows.

Analysis Stage

The analysis stage consists of analyzing needs and formulating learning. Analyzing the needs of researchers conducted interviews with students and physics teachers regarding the knowledge and needs of the products developed. While the analysis in formulating learning analyzes the curriculum in the school under study in physics subjects. Based on the results of interviews, tenth grade students are still classified as low knowledge of technological advances, information on global issues about climate change, student learning outcomes are still below the criteria and students do not have motivation in learning so that students have difficulty in understanding the material on teaching materials. The low learning outcomes of students is one of the causes of the lack of absorption of

students to the teaching materials delivered by educators because the material is difficult to understand and monotonous so it is not varied because it only uses printed books from schools (Lasriani et al., 2023). For the next learning formulation results, researchers get a physics learning tool for class ten Phase E that is used in the school. Then the device was analyzed by researchers with indicators according to the results of the analysis of the needs of students. At the end of the learning formulation analysis, researchers formulated physics learning tools on climate change sub-matter such as, learning outcomes (CP) 10.1, learning objectives (TP), and teaching modules (MA).

Design Stage

The results of the design stage consist of designing topics and compiling drafts (products). In designing topics, researchers determine and write learning outcomes (CP), learning objectives (TP), and teaching modules (MA) so that the products made are directed learning. For the preparation of the draft (product), researchers compiled a product story board, then the results of the story board were applied to be designed through the power point application. The electronic book story board using the APK builder pro website based on science, technology, engineering, implementation, and evaluation includes cover, preface, table of contents, electronic book instructions, concept map, learning objectives, content, context, exercises, competency tests and references.

Creating an electronic book requires three supporting applications, namely the power point application, the ispring suite application, and the 2 APK builder pro website application. After the story board structure design of the electronic book using the website 2 APK builder pro based on science, technology, engineering, implementation, and evaluation (STEM) was made, the researcher designed it using the power point application. The advantages of the power point application can use video, sound, and images so that the designed electronic book produces electronic books that are of interest to many students according to the results of the analysis of the needs of students. The results of the electronic book design using the website 2 APK builder pro based on science, technology, engineering, and mathematics (STEM) using power point will become a ppt format file. then the format is exported to an html-based file using the ispring application tool and converted back to the 2 APK builder pro website application into an application format file that can be installed on a smartphone so that it can be tested on a self evaluation. Self evaluation is carried out for product test evaluation before being tested to validators

so that it becomes prototype 1. The results of the product design can be seen in Figure 2.



Figure 2. Display of STEM-based climate change e-books used on smartphones

Development Stage

At the development stage there are several activity processes, namely, the validation stage and the practicality stage of electronic book products using the website 2 APK builder pro based on science, technology, engineering, implementation, and evaluation (STEM). The validation test phase of the development of climate change electronic books based on science, technology, engineering, implementation, and evaluation (STEM) was carried out on two expert validators (material, media and language). The results of the validation test on the expert review are an assessment that aims to get a valid product. Assessment of two validators using a questionnaire with the results that can be seen in Figure 3.

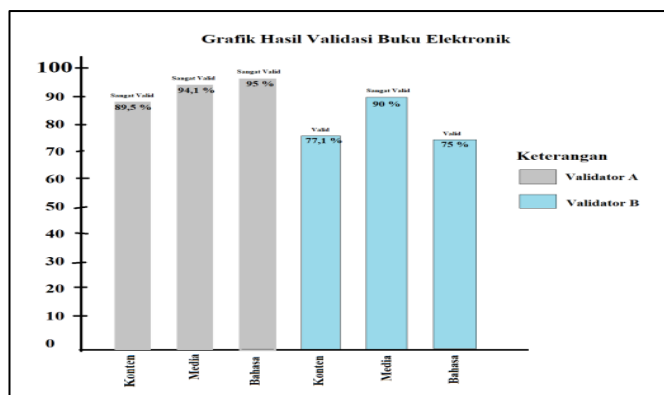


Figure 3. Graph recapitulation of validator assessment results

The results in Figure 3, the percentage of the first validator in the content aspect is 89.5%, the media aspect

is 94.1%, and the language aspect is 95% with the calculation results with very valid criteria. for the second validator with a value of 77.1% content aspects, 90% media aspects, and 75% language aspects whose average value is in the valid category. Therefore, the results of the assessment obtained from the validator can be concluded that the overall electronic book of climate change based on science, technology, engineering, and mathematics (STEM) to improve learning outcomes that have been validated at the expert reviews stage from the aspects of content, media, and language obtained criteria with an average score of 86.7% with an interval of $85\% \leq X \leq 100\%$ declared very valid.

The results of comments and suggestions from both validators to improve the product assessed during the guidance process resulted in a long validation process. The practicality stage of the product was carried out in the one to one test, small group and product assessment by physics teachers. The results of the one to one test were tested on three students which can be seen in Figure 4 below.

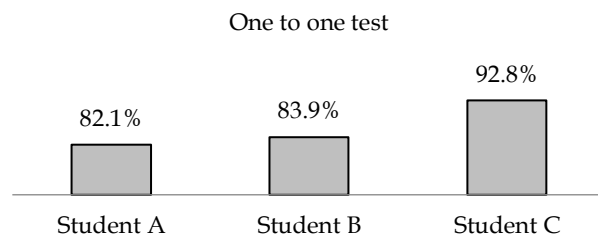


Figure 4. Graph recapitulation of one to one test results on students

The results of Figure 4, obtained an average value of the one to one test of 86.2% with an interval of 86%-100% very practical criteria. The one to one test was tested on three students from 3 students with the first result showing a score of 82.1% which means practical, the second student 83.9% with practical criteria, and the third student 92.8% which is very practical. The results obtained in the one to one test on the assessment of a questionnaire show that the assessment of electronic books using the website 2 APK builder pro based on science, technology, engineering, and mathematics (STEM) is very attractive to students on average 86.2% with very practical criteria. On the suggestion sheet, students write comments related to the learning process taking place in the classroom. The one to one test was conducted before the small group test. Furthermore, a small group test was conducted on students with a total of 32 students to fill out a response questionnaire on the product developed before entering the implementation stage in the application of electronic books using the website 2 APK builder pro based on science, technology,

engineering, implementation, and evaluation (STEM) to improve learning outcomes. The results of the small group test on 32 students can be seen in Figure 5.

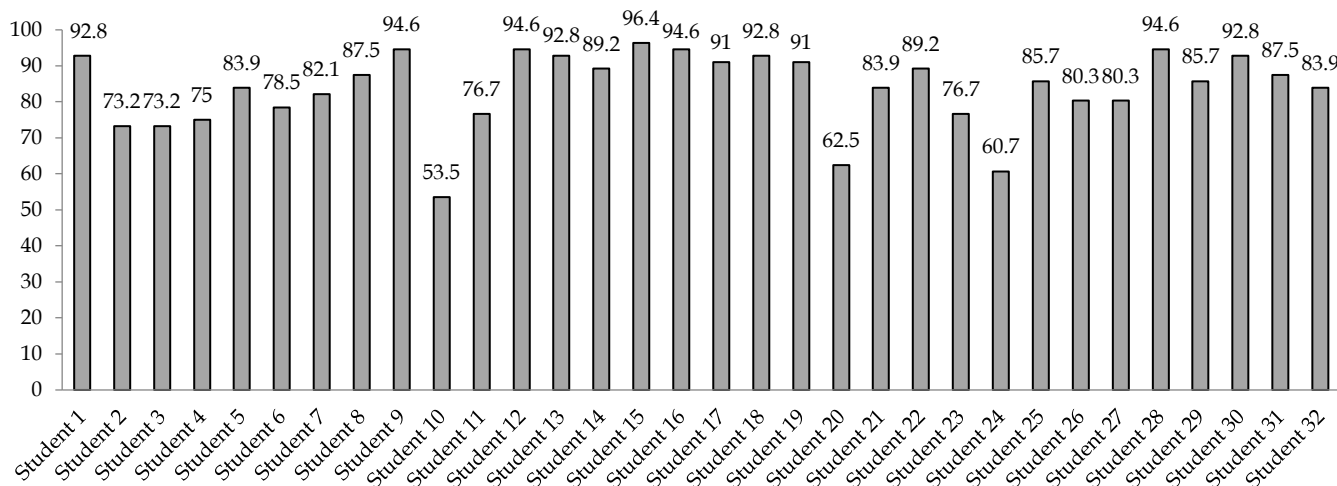


Figure 5. Graph recapitulation of small group test results on students

The results of Figure 5, in the graph above, show the results of the scores of 32 students with an average of 83.7% whose interval is 66% - 85% means practical. This small group test is applied before learning takes place in the classroom. After that at the end of testing the practicality of the product is responded to by educators to assess whether the product developed is feasible to be applied in students to carry out the learning process so that student learning outcomes increase. The results of the physics teacher assessment for product practicality can be seen in Figure 6.

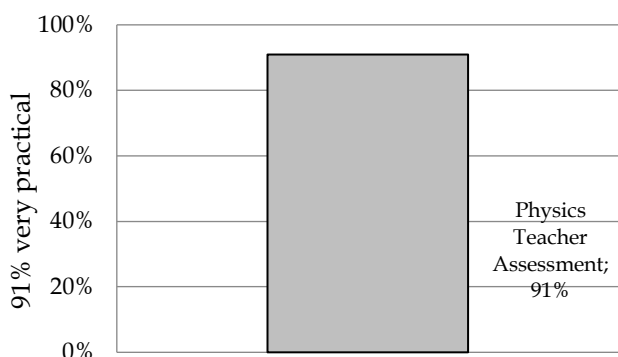


Figure 6. Graph recapitulation of the results of the physics teacher's assessment of the product

Figure 6 in the graph above, is the result of the physics teacher's assessment of the product developed with an average value of 91% in the 85%-100% interval which means very practical. So with the results of the one to one test, small group test, and physics teacher assessment stated with the conclusion that the product developed is very practical. So the electronic book using

the website 2 APK builder pro based on science, technology, engineering, implementation, and evaluation (STEM) is self-evaluated by researchers so that the product becomes prototype 2.

Implementation Stage

At the implementation stage, the field test was carried out in the tenth grade field test at the middle school level. The first meeting of learning is done pretest and at the end of the learning meeting is done posttest. The first learning process was carried out an initial stage ability test assessment on climate change material before applying electronic books using the website 2 APK builder pro based on science, technology, engineering, implementation, and evaluation. The results of the pretest scores tested on 32 students at the initial meeting can be seen in Figure 7.

In Figure 7 the graph above shows the results of the pretest test on 32 students. These results obtained the average value of students with a value of 39.1 initial knowledge of learning. After the pretest test, the second and third meetings are learning climate change material using teaching material media of the type of climate change electronic book based on science, technology, engineering, and mathematics. For the next meeting, the learning process in the classroom teaching materials used on climate change material using electronic books using the website 2 APK builder pro based on science, technology, engineering, implementation, and evaluation (STEM). In the learning process of applying the product from the researcher, the media used in the learning process is highly favored by students according to the results of the one to one and small group tests that

the electronic book of climate change based on science, technology, engineering, implementation, and evaluation (STEM) is very practical so that the learning process takes place students are active and motivated because learning

using smartphones. Furthermore, at the fourth meeting, namely the last learning, the posttest test was conducted. The results of the posttest test on 32 students can be seen in Figure 8.

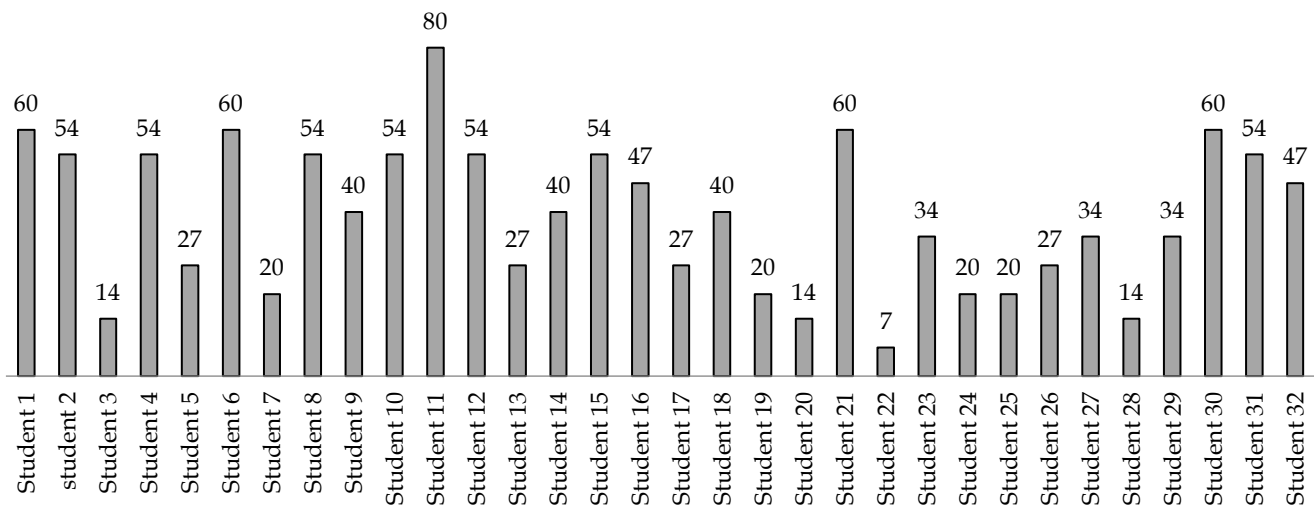


Figure 7. Graph recapitulation of pretest test results

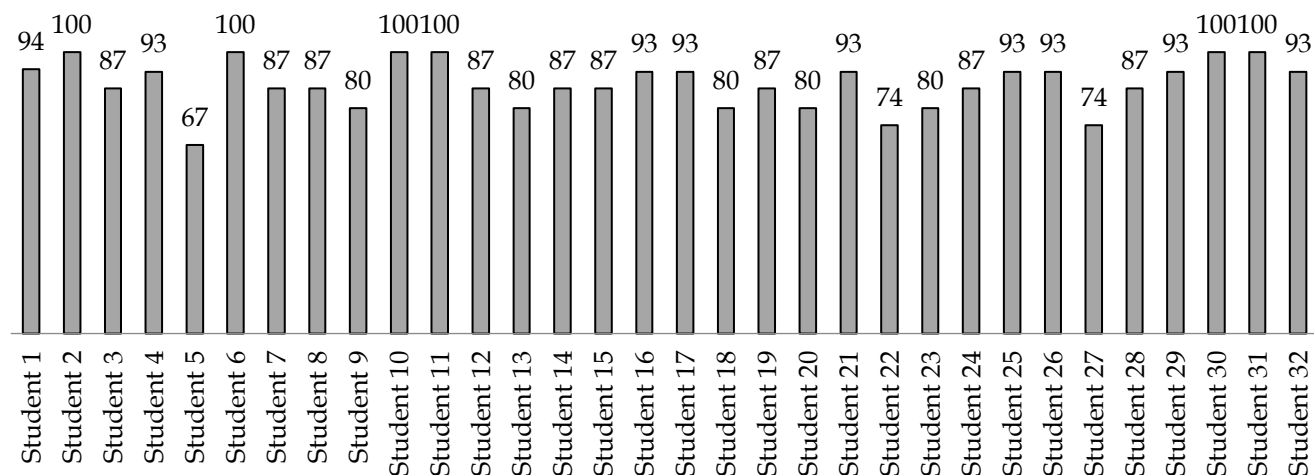


Figure 8. Graph recapitulation of pretest and posttest results

Figure 8 above is the result of data on the average value of students in the posttest test conducted on 32 students at the end of learning. These results obtained an average value of 88.6 with very high improvement results. So from the results of the implementation stage field test in the pretest test, the average value is 39.1 and the average posttest test is 88.6 and then analyzed using the N-gain test. Researchers use the Microsoft excel

application as a research assistant in analyzing the results of the effectiveness of electronic books using the website 2 APK builder pro based on science, technology, engineering, implementation, and evaluation (STEM) to see the results of the N-gain test that has been measured. The following are the results of the N-gain calculation of learning outcomes from 32 students as in table 4 below.

Table 4. N-Gain Scores and Mean Pretest-Posttest Scores of Students' Learning Outcomes

Average pretest score	Average posttest score	N-gain limitation	Categori	Number of learners	N-gain	Percentage Result
39.1	88.6	$g > 0.7$ $0.3 \leq g \leq 0.7$ $g < 0.3$	High Medium Low	32	0,8	82.6 % High

In table 2 above, there are 32 students with the results of the N-gain value of 0.8 with the limit of $g > 0.7$ and above in the high category. The pretest and posttest tests that have been conducted by researchers on 32 students of SMAN 3 Banyuasin 1 with valid data, and practical, the products developed are very effective.

Evaluation Stage

The evaluation results in this study are the validity, practicality, and effectiveness of electronic books using the website 2 APK builder pro based on Science, Technology, Engineering, And Mathematics (STEM) using a validation questionnaire to validators, student response questionnaires, physics teacher responses and the implementation of student assessments by conducting pretests and posttests. From the validation results, an assessment was obtained from two validators with an average percentage of 86.7%, while the results of the student response questionnaire showed a percentage of 83.7% and the physics teacher's response to the product was 91% with the results of the product developed being very practical. Furthermore, the results of product effectiveness with a percentage score of 82.6% with an N-gain of 0.8 are in the high category. This evaluation stage evaluates the entire test phase of each research step carried out.

This research is expected to provide relevant studies for researchers who develop an electronic book based on climate change science, technology, engineering, implementation, and evaluation (STEM) to improve learning outcomes. Researchers in developing this product require a long process step by step must be passed and followed stages. Therefore, this research is a positive step that can benefit the world of education researchers and writers. Limitations in research on the development of electronic books using the website 2 APK builder pro based on science, technology, engineering, and mathematics (STEM) to improve learning outcomes, namely, the number of respondents tested was only 32 students. That way it needs a very broad development and needs more research subjects to be tested so that the electronic book of climate change based on science, technology, engineering, implementation, and evaluation (STEM) to improve learning outcomes developed is truly tested on a larger scale or full scale.

Conclusion

The electronic book of climate change based on science, technology, engineering, and mathematics (STEM) assisted by the website 2 APK builder pro was developed based on the results of research on the average validation score at the expert review stage tested by expert experts by getting a percentage value of 86.7% with very

valid criteria, the results of product practicality research percentage with a one to one test score of 86.2% very practical criteria, small group score 83, 7% practical criteria, and 91% physics teacher assessment score very practical criteria and the effectiveness of the product is produced by increasing the learning outcomes of students with the field test stage carried out at the beginning of learning with an average pretest score of 39.1 and at the end of learning with an average posttest score of 88.6 calculated through the N-Gain test with an average score of 0.8 which means high with very effective criteria. Therefore, the electronic book of climate change based on science, technology, engineering, and mathematics (STEM) assisted by the website 2 APK builder pro produced is declared valid, practical and effective.

Acknowledgments

The research/publication of this article was funded by DIPA of Public Service Agency of Universitas Sriwijaya 2023. SP DIPA-123.I7.2.677515 /2023, On November 30, 2022. In accordance with the Rector's Decree Number: 0187/UN9.3.1/SK/2023, On April 18, 2023".

Author Contributions

The first author, Cher, is the author who fully contributed to all the research needs until it was completed. While the names of the second and third authors, Id and Is, are the supervisors of the entire research process.

Funding

This research is the result of student thesis research to support graduation in obtaining a master's degree in physics education from the researcher's personal funds.

Conflicts of Interest

The authors declare no conflict of interest.

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