



## STEM-BASED GLOBAL WARMING E-BOOK IN SUSTAINABLE DEVELOPMENT BASED ON GENDER VIEW

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### ABSTRACT

Gender has become a critical issue globally because it is one of the main goals of global collective transformation in sustainable development. This research is motivated by the absence of science teaching materials with STEM-based global warming material with the principle of sustainable development in terms of gender perspective. The purpose of this research is to develop and produce a STEM-based e-book with sustainable development principles based on gender that is valid, practical, and effective. This research is a Research and Development using the Plomp model which consists of 3 stages, namely the initial research stage, the development stage, and the assessment stage. The results showed that the STEM-based e-book with gender-based sustainable development principles obtained a validity test result of 85.85%, a practicality test result of 87.16%, and an effective test result for female students of 83, 5% while for male students is 80%. So, it can be concluded that e-books are very valid, very practical, and very effective for use in classroom learning.

## E-BOOK PEMANASAN GLOBAL BERBASIS STEM DALAM PEMBANGUNAN BERKELANJUTAN BERDASARKAN SUDUT PANDANG GENDER

### Kata Kunci:

Pengembangan e-book

Gender

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Pembangunan Berkelanjutan

### ABSTRAK

Gender telah menjadi isu yang sangat penting secara global sebagai salah satu tujuan utama transformasi langkah kolektif global yaitu pembangunan berkelanjutan. Penelitian ini dilatarbelakangi karena belum adanya bahan ajar IPA pada materi pemanasan global yang berbasis STEM dengan prinsip pembangunan berkelanjutan ditinjau dari perspektif gender. Tujuan penelitian ini adalah untuk mengembangkan dan menghasilkan e-book berbasis STEM dengan prinsip pembangunan berkelanjutan berdasarkan gender yang valid, praktis, dan efektif. Penelitian ini merupakan penelitian Research and Development dengan menggunakan model Plomp yang terdiri dari 3 tahap yaitu penelitian awal, tahap pengembangan, dan tahap penilaian. Hasil penelitian yang diperoleh adalah e-book berbasis STEM dengan prinsip pembangunan berkelanjutan berdasarkan gender dengan rata-rata hasil uji validitas 85.85%, rata-rata hasil uji praktikalitas 87,16%, dan hasil tes efektivitas pada siswa perempuan memiliki rata-rata 83,5% sedangkan siswa laki-laki 80%. Dapat disimpulkan bahwa e-book sangat valid, sangat praktis, dan sangat efektif untuk digunakan pada pembelajaran di kelas.

## 1. INTRODUCTION

United Nations member countries agreed to implement sustainable development concept to make the world a better place without destroying future generations, the idea is known as Sustainable Development Goals (SDGs) [1]. The main objectives of the SDGs are environmental social and economic development to address global challenges such as global warming and the loss of biodiversity [2]. Based on the goals, 195 countries are involved in sustainable development [1]. According to Azzahra, the steps that must be taken by the government are to commit to protecting ecosystems, promoting equality, and focusing on sustainable development, while acknowledging the interconnectedness of goals to achieve human welfare [2].

The achievement of sustainable development goals is also related to science and technology that is developing in the 21st century [3]. The role of science and technology in education is very helpful in improving the teaching and learning process and is widely accepted as a strategic advantage in improving the quality and standards of schools for students in the 21st century [4].

Integrated science learning can make students determine the subject matter, find facts about the problem, determine the answer options for the problem, determine the analysis of the selected answer, the reasons for choosing the answer, and recheck [5]. In addition, integrated science learning can also make students find new ideas from other perspectives and the ability to provide different ways of thinking, as well as the many variations in the ability to provide unusual answers, different from others and are occasionally given, as well as many variations in the ability to provide answers a different direction of thinking [6].

Efforts to realize integrated science learning can support science can be done by using science and technology based on Science, Technology, Engineering, and Mathematics (STEM). STEM creates problem-oriented learning in everyday life. Learning with the STEM approach, students can be trained to apply the knowledge they have acquired in school to phenomena that occur in the real world and the STEM approach is action-oriented because it involves solving real problems located in the context of the students themselves [7]. The STEM approach with the principle of sustainable development can create human resources in addition to being able to overcome environmental problems but can also apply their knowledge into technology that can reduce damage and issues related to the sustainable development environment so that the STEM approach model is effective because students use it in class [8]. So, the STEM approach is a vehicle for achieving the principles of sustainable development, because students can integrate various knowledge, skills, and attitudes in STEM enabling students to solve global problems in the local context of students [7]. The STEM approach process can be carried out with the help of teaching materials.

Teaching materials include printed and non-printed teaching materials. Teaching materials include books, documents, modules, brochures, and student worksheets. Meanwhile, non-printed teaching materials include listening (audio) teaching materials such as cassettes, radios, LPs, and compact disks as well as e-books [9]. One that can be accessed by students anywhere and anytime is digital books or e-books [10]. E-books contain information in electronic form which can be in the form of text, animation, or images. E-books have advantages such as small size, not easy to rot, easy to carry, and can display multimedia illustrations, such as animation [11]. E-books can help visualize abstract material so that it helps students to understand the concept better [12]. Learning using e-Books that are taught with the STEM approach will greatly affect learning outcomes. STEM-assisted learning can train students in applying knowledge to make

designs as a way to solve problems related to the environment with the use of technology [11].

Viewed from the gender aspect, gender affects the level of scientific literacy skills and attitudes concerned with the environment students. Science lessons provide opportunities for women and men to be seen as equally capable of succeeding and are considered important elements in education, especially in the STEM approach. scientific research, science education, work practices by utilizing technology in all fields [13]. Gender equality is fundamental to realizing sustainable development. However, gender inequality still applies in Indonesia, both the public space, domestically, and even in the learning process so it hinders participation to participate get involved in the achievement of goals [14].

Several studies have been conducted regarding the development of STEM-based e-books, including: STEM-based e-book on ecosystem materials to train students' scientific literacy skills [15], the effect of using STEM-based e-book on conceptual understanding [16], applying STEM to the mathematical statistics e-module [17], and developing STEAM-based e-module on 21st-century skills in terms of gender differences [18]. Of these several studies, no one has developed a STEM-based e-book based on gender perspectives.

This study aims to complement research on teaching materials. Researchers innovate by creating e-book using STEM approach with the principles of gender-based sustainable development. The purpose of this research is to develop and produce a STEM-based e-book with the principles of sustainable development based on gender, which is valid, practical, and effective.

## **2. METHOD**

The research method used is the Plomp research and development (R&D) model which consists of three stages of development, namely the preliminary research stage, the development of the prototype phase, and the assessment phase [11].

### **2.1 Preliminary Research**

At this stage there is a needs analysis that aims to find out what needs are needed to overcome the problems found in the learning process, the needs analysis is carried out by interviewing science teachers and students. Literature analysis was conducted to find a theoretical basis that strengthens the development of digital books with the principles of sustainable development of scientific literacy and an attitude of caring for the environment from a gender perspective. The stages of literary analysis are curriculum analysis, media analysis, material analysis, and concept analysis.

### **2.2 Development and Prototyping Phase**

This stage is a continuation of the first stage which aims to produce a prototype e-book on global warming based on STEM that is integrated with valid sustainable development principles. This stage consists of three activities, namely: designing a prototype, conducting formative evaluation, and revising the prototype.

### **2.3 Assessment Phase**

The purpose of this stage is to explore the practicality and effectiveness of the STEM-based global warming e-book prototype with the principles of gender-based sustainable development. The level of practicality can be seen from the answers to the practicality questionnaire for science teachers and students' practicality questionnaires. The

effectiveness of the STEM-based global warming e-book with the principles of sustainable development can be seen from the students' answers to questionnaires and tests.

The product of this research is an e-book on global warming based on STEM with the principles of sustainable development based on a gender perspective. Based on the development steps that have been stated, it can be described as part of the flow as shown in Figure 1 below [11].

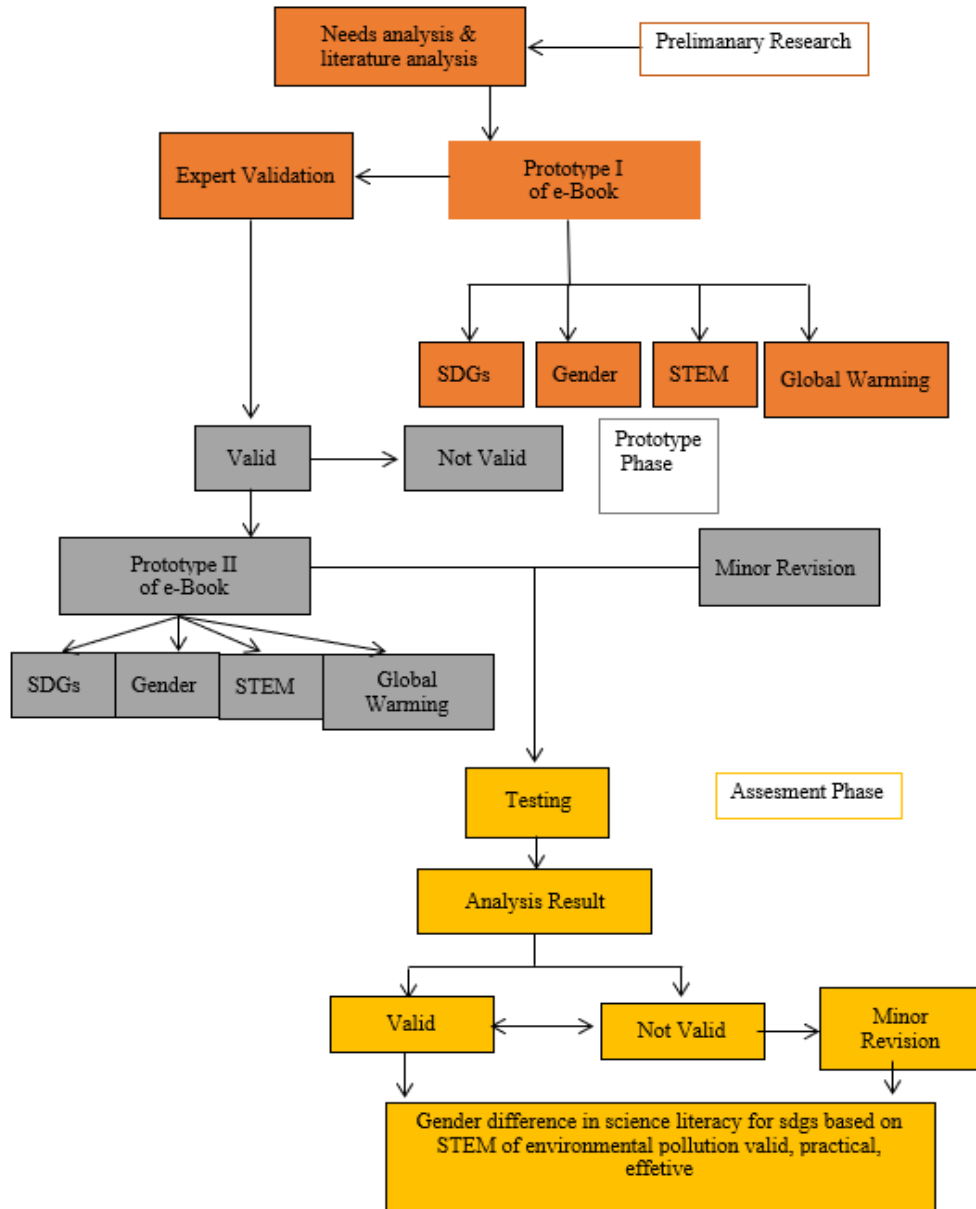


Figure 1. Research Flow

In Figure 1, the first stage is a needs analysis and literature analysis from the title, then create an e-book product design by entering the variable titled, and then validated, there are valid and invalid. if valid, proceed to the second stage, namely development and there is a slight revision after revision of product trials by analyzing needs. If valid, with slight revision, it will produce an e-book on the Gender difference in science literacy for SDGs based on STEM of environmental pollution valid, practical, effective.

The data collection instrument in this study was carried out using several techniques, which can be seen in Table 1.

**Table 1.** Data Collection Instruments

No	Instrument	Criteria
1	Validation	<ul style="list-style-type: none"> <li>• Validation instrument assessment sheet</li> <li>• Practicality instrument assessment sheet</li> <li>• Effectiveness instrument assessment sheet</li> <li>• STEM-based global warming e-book validation questionnaire with sustainable development principles based on gender perspective</li> </ul>
2	Practical	<ul style="list-style-type: none"> <li>• Practicality questionnaire by educators</li> <li>• Practicality questionnaire by students</li> </ul>
3	Effective	<ul style="list-style-type: none"> <li>• Questionnaire for scientific literacy and environmental care for students</li> <li>• Analysis of questions</li> </ul>

The data collection technique used a questionnaire consisting of a validity questionnaire, a practicality questionnaire, and an effectiveness questionnaire. The validity questionnaire was given to 3 validators (1 material/content validator, 1 media validator, and 1 language validator). The practicality questionnaire was filled out by 2 science teachers and 20 students. The effectiveness questionnaire filled out by students is useful to see the practicality of the STEM-based global warming e-book with the principles of sustainable development based on a gender perspective.

There are two types of data in this study: quantitative and qualitative data. Qualitative data was obtained from survey results, and qualitative data were obtained from suggestions or opinions of validators and practitioners. Qualitative data processing is done by the qualitative descriptive method. Evaluation/response data analysis questionnaire based on product validation and test results. The data collected were analyzed using a Likert scale technique with a positive category, namely positive statements getting the highest weight.

### 3. RESULTS AND DISCUSSION

The initial investigation stage is carried out by analyzing the problems and needs of teachers and students regarding global warming e-books. Analysis of the problems and needs of teachers and students in this study was conducted to determine the problems faced by teachers and students during the learning and teaching process on global warming subjects in the global warming e-book. Researchers collected data by interviewing teachers and students of SMPN 1 Tj. Mutiara.

The ability of students to master global warming material can be influenced by several factors, one of which is teaching materials. The available teaching materials are not practical to obtain. Based on the results of interviews with science educators, it is known that the material is less practical and has a real effect on sustainable development. Lack of students' ability to read, reason, and ask questions. This shows low learning motivation. However, at this time, students are asked to seek information by utilizing their Android smartphone and tablet products. This shows that students tend or prefer to learn to use information technology that is currently developing.

Based on the results of observations made, it was found that the willingness of students to obtain teaching materials was very lacking. Students are also constrained in understanding global warming material due to the lack of interest in reading students towards the provided textbooks, textbooks that are less interesting and boring. One way for students to learn actively and effectively to increase students' learning desire is to use teaching materials. Teaching materials can be like e-books. E-books can make it easier for students to understand the subject matter [19].

The results of the study using the Plomp model can be seen in the Table 2:

Table 2. Preliminary Research


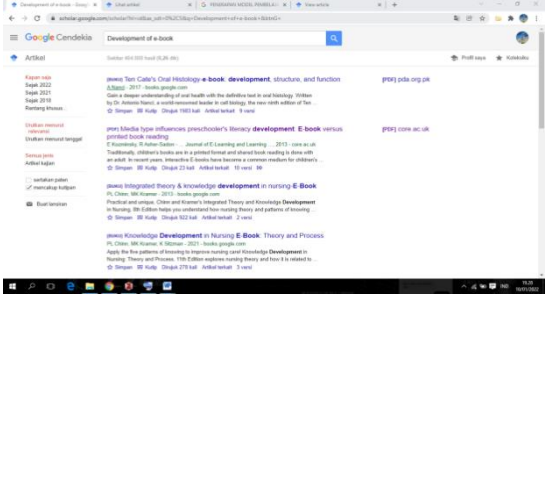
Needs Analysis	Literature Analysis
<p>At this stage, the researcher collects, analyzes information, and defines problems related to learning resources. Based on the notes on the scope of the case study during observations at SMPN 1 Tj. Mutiara researcher has conducted interviews with Ibu Rosmalina, S.Pd as a science educator at SMPN 1 . Tj. Pearl. Interviews were conducted with teachers on December 28, 2020.</p> <p>In addition, interviews with students of SMPN 1 Tj. Mutiara was also conducted</p>	<p>The analysis is carried out to determine the concepts or theoretical foundations that strengthen STEM-based e-books with the principles of sustainable development on scientific literacy</p>
	

Table 2 shows the results from the preliminary research, namely needs analysis ( teachers and students) and literature analysis when developing an e-book STEM-Based on science literacy based on gender.

Based on the results of the table above, it can be concluded that teachers need interesting, interactive learning media and media that can facilitate students in understanding learning material so that students can be active and independent in learning, and for students need e-books that teachers need learning media. interesting, interactive, and media that can make it easier for students to understand the learning material, so that students can be active and independent in learning [11].

This analysis is carried out to find concepts or theoretical foundations that strengthen the literature on the gender difference in science literacy for SDGs based on the stem of environmental pollution. The development stage is shown in Table 3.

Table 3. Development Stage

Designing A Prototype	Formative Evaluation	Prototype Revision
<p>At this stage, a STEM-based e-book is designed with the principles of sustainable development on scientific literacy. An example of an e-book cover design can be seen below.</p>	<p>The goal is to produce a STEM-based e-book with valid gender-based sustainable development principles. The validator of STEM-based e-book with sustainable development principles consists of 3 lecturers at UIN Imam Bonjol Padang consisting of 1 material expert, 1 media expert, and 1 language expert.</p>	<p>Revision of the product design is carried out based on input and suggestions from the validator on formative evaluation. At this stage, prototype II of a STEM-based e-book with the principle of sustainable development was produced.</p>

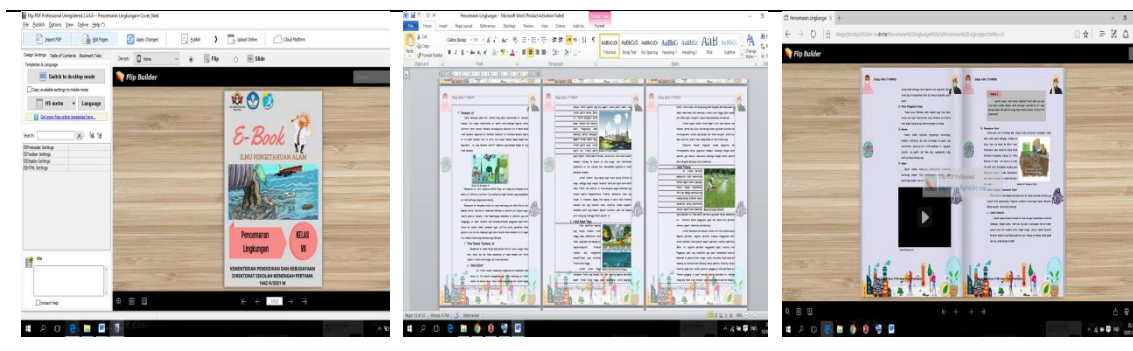


Table 3 shows the prototype development stages, namely those carried out by content, media, language validators for the developing e-book global warming STEM-Based on sustainable development based on gender.

This stage is a continuation of the first stage, which aims to produce an integrated STEM-based science e-book prototype with valid sustainable development principles. This stage consists of three activities, namely: designing a prototype, conducting formative evaluation, and revising the prototype [11]. The last stage is the assessment stage, which can be seen in Table 4.

**Table 4. Assessment Phase  
Practicality And Effectiveness Assessment**

The purpose of this stage is to see the practicality and effectiveness of the prototype II STEM-based digital book with the principle of sustainable development as a result of the development phase. The level of practicality can be seen from the answers to the practicality questionnaire by 2 science teachers and the practicality questionnaire by 20 students of SMPN 1 Tj. Mutiara Grade VII. The effectiveness of STEM-based digital books with the principle of sustainable development on scientific literacy based on students' answers to questionnaires and scientific literacy tests and questionnaires.

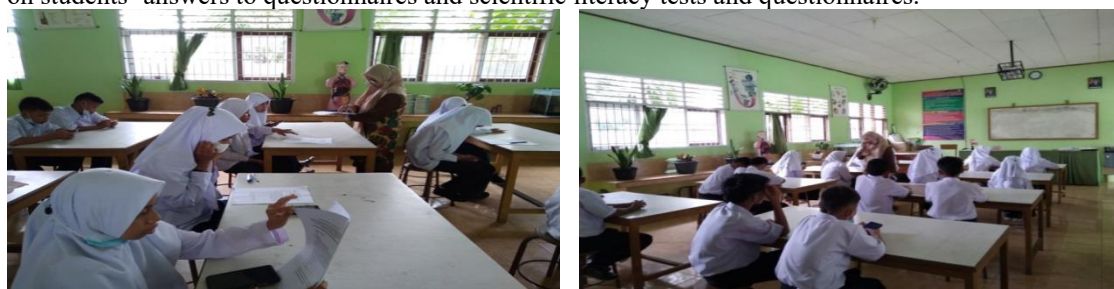


Table 4 is the assessment stage, which is to see the practicality and effectiveness of the developed e-book that was developed which was filled in by teachers and students.

The practicality test was obtained from distributing questionnaires to science teachers at SMPN 1 Tj. Mutiara and 20 students of class VII SMPN 1 Tj. Mutiara. The statement indicators for the practicality test by teachers are 12 statements and students are 12 statements. The effectiveness of a STEM-based e-book with the principle of sustainable development on environmental pollution materials can be seen by distributing scientific literacy questionnaires to 20 seventh-grade students at SMP Negeri 1 Tj. Mutiara consists of 10 girls and 10 boys. The effectiveness sheet consists of 8 questions about students' responses to scientific literacy.

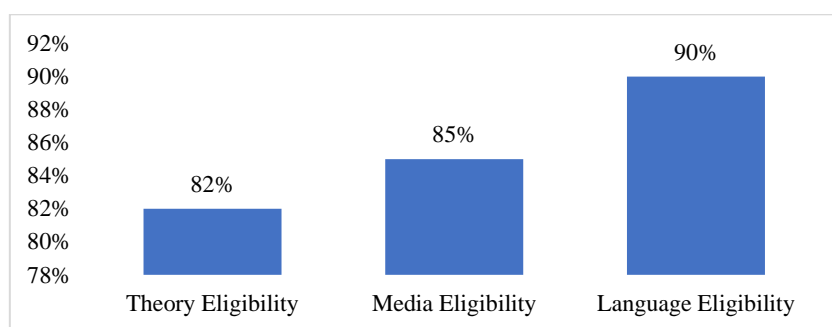
The effectiveness sheet was filled out by 20 students consisting of 10 women and 10 men. The scores obtained from 20 students were converted into grades. The results of the assessment of each stage are as follows.

### 3.1 Validity Test

The results of data analysis show expert validators' responses to conformity based on the statements in the assessment questionnaire items to assess the advantages and disadvantages of the developed e-book. [4], as well as a basis for making improvements according to the suggestions given [20].

The results of the assessment of material aspects with an average score of 82.22%, this number shows that e-books on material aspects are categorized as very good, this is very important because basically, the systematic arrangement of learning materials determines the achievement of experiences and learning outcomes that are by the objectives learning. The feasibility of the e-book material aspect is seen from the suitability of the global warming material presented with the students' thinking level as well as KI, KD, and learning objectives that have been set [20].

The results of the media feasibility test based on questionnaire data analysis show that the e-book has met the indicators of good media assessment with an average score of 85.33%. The presentation of attractive media is important to provide visualization of the learning activities presented. The results of the assessment of the use of the linguistic aspect of the e-book get an average value of 90%, the results of the assessment show that the use of language is following general Indonesian spelling guidelines. The assessment obtained is in the very good category to support the communicative activities of students. These results support the researcher's assumption that e-books are valid so that they allow students to learn and practice all of their skills, including language skills, listening, and interacting using technology. Similar results were also expressed by Aswirna and Ritonga that a valid e-book can improve the learning process of students [11]. Similar results were also expressed by Andaresta and Rachmadiati in their research which stated that e-books were very valid empirically and theoretically to increase students' knowledge [19]. The category of the assessment can be seen in Figure 2.



**Figure 2.** Data Graph of Material Validity Test Results, Media Validity, and Language Validity

Figure 2 shows the results of the e-book validity and it has met the criteria and the elements of e-book preparation so that it is suitable for use in learning. The average percentage is 85.85%, it is revealed that the STEM-based e-book on global warming with the principles of sustainable development is categorized as very valid. Similar results were also expressed by Andaresta and Rachmadiati that the developed e-book can be said to be a good teaching material and suitable for use in the learning process [19].

### 3.2 Practicality Test

STEM-based global warming e-book with the principles of sustainable development that has been validated and then conducted a feasibility test. The practical results of the STEM-based global warming e-book with the principle of sustainable development are



divided into two, namely the practical test by science teachers at SMPN 1 Tj. Mutiara and practicality test by class VII students of SMPN 1 Tj. Mutiara.

The practicality test was obtained from the distribution of questionnaires filled out by 2 science teachers with 12 statements and 20 students with 12 statements. The average results obtained from the results of the STEM-based integrated science digital book practicum with the principle of sustainable development by teachers and students can be seen in Figure 3.

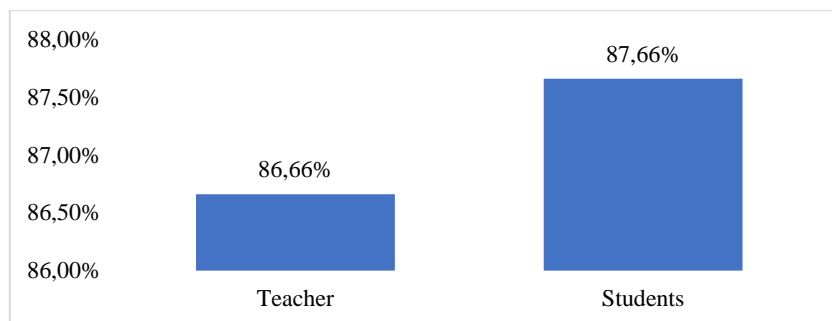


Figure 3. Data Graph of Practicality Test Results by Teachers and Students

Judging from the results of practitioner analysis by teachers and students, the average percentage is 87.16% with very practical criteria. This shows that global warming e-books can be used by teachers and students in the learning process

### 3.3 Effectiveness Test

The effectiveness test is useful to see the effectiveness of the STEM-based global warming e-book with the principles of sustainable development based on a gender perspective. Effectiveness data were obtained from the learning competencies of students which included knowledge competencies obtained from questionnaires and tests. The e-book effectiveness test uses a questionnaire and a test consisting of 8 questionnaire statements and 10 test questions.

The effectiveness sheet was filled out by 20 students consisting of 10 female students and 10 male students. The average score of the results of the questionnaire and the assessment test of female and male students on the STEM-based e-book on global warming with the principles of sustainable development can be seen in Figure 4.

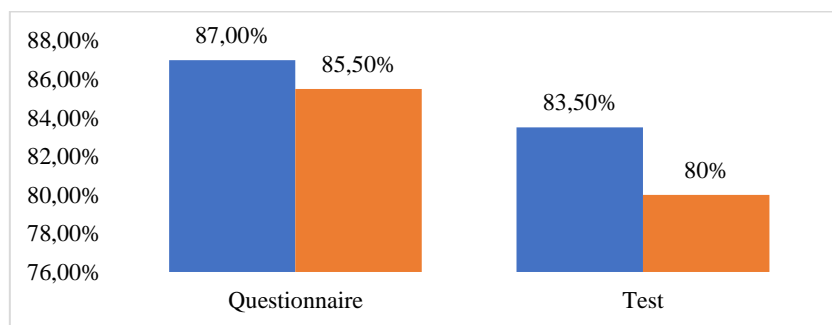


Figure 4. Graph of Global Warming E-Book Effectiveness Test Results Grafik

Judging from the results of the analysis of the effectiveness of digital books for female and male students in the questionnaire, they were 87% and 85.5%, respectively. and for the test female students have an average of 83.5% while male students are 80%, categorized as very effective.

The effectiveness test was conducted to determine the results of using the global warming e-book in learning activities. The use of e-books on global warming has a positive effect on the knowledge competence of students. This is because the e-book contains material on global warming that can hone students' abilities. In the e-book, global warming material is presented according to the curriculum, and global warming syllabus. Thus, understanding the concept of students from learning global warming can be achieved well [11].

Sustainable development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs. As well as developing an e-book on STEM-based global warming with the principle of sustainable development in terms of gender that can be applied by students in everyday life to protect the environment, in which protecting the environment is one of the principles of sustainable development and gender [21].

Gender is a cultural concept that seeks to make a difference in roles and responsibilities as well as actors who will shape the emotional characteristics between women and men [22]. The gender difference explains that in the male brain the left brain is more developed so that he can think logically, think abstractly, and think analytically so that it can be said that male students dominate STEM in the fields of mathematics, technology, and engineering. Meanwhile, women have more developed right brains, so they tend to move in an artistic, holistic, imaginative, intuitive thinking and some visual abilities so that women dominate STEM in the field of science [19].

Gender has an impact on human development [23]. According to the research of Prianto, et al that gender also influences a student in viewing and choosing science topics and subjects they like. This is related to the differences in the characteristics and learning activities of each subject in a learning institution [24].

In addition, many parties and colleagues have different views on the performance and characteristics of male and female students. Male students are more often perceived as less motivated to learn [25]. Motivation is a predictor that often has a significant impact on a person's academic achievement [26]. In addition, male students are also considered to have a less favorable attitude than female students.

Differences in views of male and female students can also be shared by teachers to parents. Sometimes, the two parties have different expectations of students of different genders [27]. In fact, according to the results of this study, gender does not always have a significant impact on a person's academic achievement. These results support the findings of various previous researchers. The reason is that the intellectual abilities of men and women are often at the same level [28].

The development of a STEM-based e-book on global warming with the principle of sustainable development from a gender perspective provides opportunities for women and men to be seen as equally capable of success and is considered an important element in education [13]. Education is needed to prepare the younger generation so that they can live and fulfill life goals more effectively and efficiently [29]. According to several studies, people have identified important differences between men and women in education for a long time [30], [31]. Through this research, researchers have succeeded in providing solutions to support gender-based sustainable development voiced by the United Nations. What's more, this research has perfected previous research that only made STEM-based E-Books aimed at scientific literacy skills [19], which in this study were refined on the topic of global warming in gender-based sustainable development.

#### 4. CONCLUSION

Based on the results of the development and testing of the global warming e-book, it can be concluded that the results of the global warming e-book development are as follows. The validity of the global warming e-book has very valid criteria. The practicality of the global warming e-book developed according to teachers and students is very practical. The effectiveness of the global warming e-book that was developed based on gender, that is, female students, dominate the effectiveness of questionnaires and tests compared to male students. So there are gender differences in the ability to understand global warming material.

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