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Development Module of Global Warming Issue to Train Science, Technology, Engineering, and Mathematics (STEM) Literacy

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Abstract

Teaching materials can improve students' skills. Global warming material is important to learn to solve social problems or global issues. Therefore, this study aims to develop an integrated STEM module on global warming material to train learners' STEM literacy. This research method is Research and Development (R&D). The data is analyzed descriptively. N-gain is used to determine module effectiveness and improve students' STEM literacy. The sample in this study was class X which amounted to 36 learners. The results showed that the STEM-based modules developed had criteria suitable for use in the learning process in terms of suitability of the material with STEM with a validation score of 0.75 in the high category (feasible), and aspects of the feasibility of teaching materials which were divided into several assessments with a score of 0.87 in the very high category (very feasible), module design with a score of 0.86 in the very high category (very feasible) and the language component with a score of 0.85 in the very high category (very feasible), The average perception of learners towards the use of modules in the overall learning process is 70.53 medium categories. STEM-based modules are suitable to be used as an alternative source of learning global warming in physics learning to train students' STEM literacy.

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INTRODUCTION

Teaching materials are one of the most important factors in supporting the learning process. In the learning process, students not only interact with teachers, but students also need learning resources to understand learning. If students understand learning by using teaching materials, then the teaching materials help optimize student learning outcomes which can then achieve the desired learning goals.

One of the learning objectives is to prepare students to enter the world of work later. To face the world of work, students must have the skills needed in the 21st century. 21st century skills are important skills that must be mastered by everyone to succeed in facing challenges, problems, life, and careers in the 21st century, and we will not be left behind by the progress of scientific and technological development. The National Education Association (n.d.) has identified 21st-century skills as "The 4Cs." "The 4Cs" include critical thinking, creativity, communication, and collaboration. The use of STEM-based teaching materials can have a good impact on improving students' reasoning skills (Fitriani et al., 2017), students' ability to think creatively, improve students' understanding of concepts, and critical thinking skills (Pangesti et al., 2017). Teaching materials can be books, handouts, modules, etc. Furthermore, Khalil and Osman stated that strengthening STEM Education in Modules can help students acquire the knowledge and skills needed for them to compete in future working life (Khalil & Osman, 2017).

STEM education is closely related to STEM Literacy. Bybee stated that one of the global challenges faced by STEM education is developing STEM Literacy as a goal and identifying new learning outcomes, curriculum programs, and teaching practices (Bybee, 2013). Furthermore, Mohr-Schroeder, et al stated that STEM literacy is very important for every student because it can practice innovative learning, collaboration, creativity, problem solving and critical thinking, as well as communication skills (Mohr-Schroeder et al., 2020).

Based on observations at one of the Karawang High Schools, it is known that the STEM literacy of students is still low, this is reinforced by the results of researcher interviews with several students at the school (1) There are no interactive learning media available, the learning media used during the learning process is limited to the use of projector media. The unavailability of the use of interactive learning media makes students lack technology knowledge; (2) The teaching materials used in schools are less attractive. The teaching materials used only focus on the guidebook. Meanwhile, students need additional teaching materials that can help them understand physics learning material. Both during the learning process and outside of physics learning; (3) Students are still rarely directed in solving problems with a concept. So that students have difficulty understanding abstract physics concepts; (4) The lack of knowledge of students about Science, Technology, Engineering, and Mathematics (STEM), in the physics learning process should integrate between disciplines but in fact after observation in the field physics learning only focuses on physics content. The World Economic Forum's (WEF) students in the 21st century will work in jobs that did not exist when they started school, they need digital skills to meet the demands of Industry 4.0. The WEF also forecasts an increase in jobs in STEM fields for the coming years (World Economic Forum, 2020). So the need for integrated STEM modules to be used in the learning process to train students' STEM literacy so that students can be prepared to enter the world of work later.

The National Research Council states that all citizens must have the necessary skills and competencies to face the challenges of information and technology-based society (Council, 2014). STEM-integrated education can successfully address today's technological and global challenges (Knipprath et al., 2018). STEM literacy is awareness of the nature of science, technology, engineering, and mathematics, and familiarity with the fundamental concepts of each discipline should be an educational priority for all learners (Bybee et al., 2006). In addition, the Education unit also has an important role in preparing the younger generation to face a more competitive future, especially in preparing the skills needed for the future.

One of the most important components in preparing these skills is to improve the existing Education curriculum. Currently in Indonesia, especially in one of Karawang High Schools using a new curriculum, namely the independent

curriculum. Changes in the curriculum from the revised 2013 curriculum to an independent curriculum have made changes in approaches, strategies, methods, and learning models (Mabsutsah & Yushardi, 2022). Angga in his research stated that the challenge in implementing the independent curriculum is that there is still a lack of learning facilities and learning resources are still incomplete (Angga et al., 2022). In addition, the advantage of implementing the Independent Curriculum is that teachers can be creative and innovative in learning (Mabsutsah & Yushardi, 2022). Teachers are required to be able to compile innovative and interactive teaching materials that are by the curriculum, the development of student needs, and the development of information technology (Khulsum et al., 2018). Learning objectives will not be achieved if the facilities in the learning process are not met. Therefore, it is important to optimize the development of teaching materials in the form of modules that suit the needs and characteristics of students. By developing modules, students can learn anywhere and anytime without having to rely on teachers as a source of learning information. In line with this, Mabsutsah and Yushardi in their research stated that teachers need the development of STEAM-based e-modules and independent curricula that are easy to understand, easy to use, and effective to improve learning outcomes and science process skills of students that can be used by teachers and students (Mabsutsah & Yushardi, 2022). Furthermore, the development of teaching materials can support independent curriculum learning on the concept material and the impact of global warming (Camelia et al., 2023).

Research on STEM literacy is currently not widely carried out in Indonesia and other developed countries, especially in developing STEM-based physics modules designed by the needs of an independent curriculum to train students' STEM literacy at the senior high school (SMA) level. The module is very dependent on learning material, while the material that will be used in the development of this module is related to the topic of climate change and global warming. Climate change and global warming material is important to study because it is to solve social problems or global issues. Furthermore, Baran, et al stated that there are several issues related to Society 5.0 problems including climate change and global warming, renewable energy sources, genetic cloning, and ecological crises (Baran et al., 2021). Increasing temperatures on the surface of the earth (global warming) can disrupt ecosystems and biota mechanisms on earth, especially forests as a means of recycling carbon dioxide in the air. In addition, it results in melting ice in polar regions to increase the volume of seawater and threaten land differences (Pratama & Parinduri, 2019). Therefore, global warming needs to be addressed immediately because global warming can cause huge socioeconomic and ecological losses (Wu et al., 2022).

STEM-based worksheets are effective in increasing students' knowledge, data literacy, and students' technological literacy (Dier & Asrizal, 2023). STEM education can make students scientifically literate, carry out problem-solving procedures, and can affect students' science literacy (Yuliati & Saputra, 2019). Therefore, this study aims to develop a STEM-based module on the topic of global warming to train learners' STEM literacy skills.

METHODS

This research uses the method of Research and Development (R&D). R&D is a research method that uses stages to produce a particular product and test the effectiveness of that product (dalam Sugiyono, 2017). Brog & Gall revealed that R&D is a research method used to design new products and procedures that are field-tested and refined to meet certain criteria (Borg & Gall, 1984) In this study, the product in question is teaching materials in the form of STEM-based physics modules to train STEM literacy Learners.

The module development compiled in this study refers to 4D models (Four-D Models) which are adopted from (Thiagarajan, 1974) The 4D development model consists of 4 main stages, namely: Define, Design, Develop and Disseminate. The stages of development research according to Thiagarajan consist of:

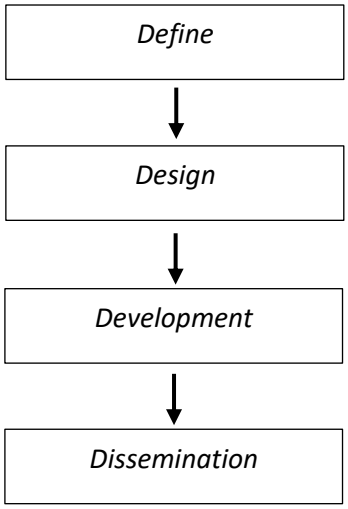

Figure 1. Research and Development Step According to Thiagarajan (1974)

Based on figure 1 Define, contains activities to determine what products will be developed, along with their specifications. This stage is a needs analysis activity carried out through research and literature studies. The design contains activities to make designs for products that have been determined. The development consists of making designs into products and testing product validity repeatedly. until the product is produced to the established specifications. Dissemination contains activities to disseminate products that have been tested for use by others.

The sample in this study was one of class X which amounted to 36 learners. The sampling technique uses a random class (cluster random sampling). The physics subject matter in the module is developed based on the current Indonesian curriculum (Curriculum Merdeka). The learning module contains STEM concepts about global warming for grade X learners. Within the module, each page has a different focus on science, technology, engineering, and Mathematics topics depending on what is studied on the page.

Data in this study were obtained through interviews, questionnaires, suitability of material with STEM, suitability of modules with STEM literacy, module feasibility, module readability, and student responses. Data collection through interviews is carried out to obtain data analysis of the needs of students and teachers related to the needs of modules needed in learning activities. While questionnaires are used to obtain module validation/feasibility tests developed based on assessments from material, media, and language experts, student comprehension/readability test sheets on modules, and questionnaires on student perceptions of STEM-based modules. The data needed in the form of material conformity with STEM, module suitability with STEM literacy, and module feasibility reviewed from expert validation in this case 3 validators will assess the instruments needed in this study. Readability data is obtained from 3 students who will assess the module related to their understanding of the module that has been developed. Furthermore, student response data is obtained through learning, then they will respond to the modules that have been developed.

The analysis technique of expert validation results is using Aiken validation techniques. by providing answer choices from instruments that have been made by giving a certain score. Validation analysis techniques in this study were used to analyze several instruments, namely the suitability of material with STEM, the suitability of modules with STEM literacy, and the feasibility of teaching materials. The results of the validation calculation are then interpreted into a table of criteria adopted by (Hendryadi, 2014) Equation 1 (Aiken's equation) is:

$$V = \frac{\sum s}{|n(c-1)|} \qquad \ldots\ldots\ldots\ldots (1)$$

Which:
$s = r - l_o$
lo = lowest validity assessment number
V = Aiken validation value
c = highest validity assessment number
r = validator-given number
n = number of panelists

From the results obtained, the data that was originally in the form of quantitative percentages were changed to descriptive qualitative. The quality of product eligibility (module) can be determined by the eligibility criteria of the validation results in Table 1 as follows:

Table 1. Validation Criteria

Validation Score	Criteria
0,8 >	Very High
$0,6 > X \leq 0,8$	High
$0,4 > X \leq 0,6$	Satisfactory
$0,2 > X \leq 0,4$	Low
0,2	Very low

The readability analysis data was collected through questionnaires given to three students. The readability test measures aspects of the layout, content, and usability of STEM-based modules for use in class X. The results of the questionnaire are calculated in equation 2 below, then the results will be interpreted into scoring criteria by (Ali, 1993):

$$Readability\ Score = \frac{Raw\ Score}{Maximum\ Score} x\ 100 \ldots\ldots\ldots(2)$$

After obtaining the results, then interpret the understanding of modules with classification based on criteria according to (Rankin & Culhane, 1969) according to Table 2 below:

Table 2. Module Readability Interpretation Criteria

Readability Score	Criteria
$0 < x \leq 40$	High
$40 > x \leq 60$	Satisfactory
$x > 60$	Low

Student perceptions for each indicator regarding the module used as a research instrument using scoring for each student's answer. The approval rate of each item can be calculated using Equation 3:

$$Student\ Answer = \frac{The\ total\ score\ of\ student}{The\ maximum\ score\ of\ student} x\ 100 \ldots\ldots\ldots (3)$$

Quantitative data can be interpreted into qualitative criteria based on (Ali, 1993). The following criteria for interpreting students' perceptions of the modules used can be seen in Table 3:

Table 3. Student Perception Criteria

Score (X)	Criteria
$77{,}77 < x \leq 100$	High
$55{,}54 < x \leq 77{,}77$	Satisfactory
$33{,}31 < x \leq 55{,}54$	Low
$x < 33{,}31$	Very Low

RESULTS AND DISCUSSION

Module development is carried out based on 4 stages: Define, Design, Develop and Disseminate. Overall, the five stages can be described as follows.

Define

His stage aims to analyze and determine learning needs. These learning needs pay attention to the curriculum applicable in schools, the stage of student development, and school conditions. At this stage, researchers also conducted field studies to obtain information about problems or obstacles experienced by both students and teachers in learning physics. Researchers also conduct literature studies related to solutions to problems found during the field study process. Based on the results of the analysis of the problems faced by teachers in physics learning is that interactive learning media is not yet available, and the learning media used during the learning process is limited to the use of projector media making students lack technology knowledge. Moreover, Students are still rarely directed in solving problems with a concept. So that students have difficulty understanding abstract physics concepts, students consider physics learning only about applying formulas, and students tend not to be active in learning. Based on the findings, students are motivated to learn only when doing practice or making a project, but the project applied in the learning process so far has not led to solving a problem.

Furthermore, the teaching materials used in the learning process so far have only focused on the guidebook. Meanwhile, students need additional teaching materials that can help them understand physics learning materials that can be used both during the learning process and outside of physics learning. Physics learning should integrate between disciplines, but the fact that physics learning only focuses on physics content. Meanwhile, based on the world economy, the future work forum is closely related to science, technology, engineering, and mathematics. So the need for integrated STEM learning to train students' STEM literacy so that students can be prepared to enter the world of work later.

From the results of various problems previously described, teachers and students need interactive and interesting learning media so that they can motivate students in the learning process. The media must train the skills needed by students to face the world of work. One of the learning media that is believed to be able to overcome these problems is in the form of STEM-based modules to train students' STEM literacy. The material selected

based on field studies is the chapter on global warming based on the current curriculum in Indonesia (Curriculum Merdeka).

Design

This stage is carried out by determining the idea of developing STEM-based physics modules to train students' STEM literacy on global warming material. The steps taken are in the form of preparing module designs, validation sheets, instruments to assess STEM literacy, and 146instruments to determine student responses to the use of the modules developed.

Modules are arranged according to the design that you want to display including the display cover, introduction to the module, material placement design, and closing design containing student evaluation instruments. The STEM literacy question instrument is not attached to the module but will be given to students before and after learning physics using the module that has been designed later. The module has integrated STEM by training students' STEM literacy on each topic, therefore there is a different topic focus on each module page such as science, technology, engineering, and mathematics topics depending on what is studied on the page. After the module is completed, the preparation of teaching modules is carried out by the flow of learning objectives (ATP), learning outcomes (CP), and the learning steps in the module.

At this stage, the development of STEM-based learning modules (draft 1) is carried out. The design module uses Canva which can be accessed on the following web https://www.canva.com/. Worksheet template module on Canva, with A4 paper format. Modules are arranged based on an independent curriculum with the subject matter of global warming, integrated STEM, and a predetermined writing structure. The development of module preparation is carried out by making covers, applying STEM-integrated global warming materials, training students' STEM literacy with several questions that have been listed in the module, and inserting evaluation questions in the form of multiple choice at the end of learning modules The evaluation questions can be accessed with a QR code. Furthermore, in the module, there is also a student worksheet (LKPD) to train students' engineering design literacy. An example of the design of the module to be developed can be seen in the following Figure 2:

Develop

Draft 1 has been developed and will be given to validators (expert lecturers and physics teachers) for examination/validation so that the developed product is suitable for use. Furthermore, the researcher will revise according to the suggestions and inputs provided by the validator (draft 2). The module validation sheet is designed by analyzing several aspects, namely:

a. Compatibility of material with STEM (science, technology, engineering, and mathematics)

The instrument of conformity of material with STEM is divided into several contents, namely 1 statement on the content of the STEM structure, 4 statements of STEM definitions, 4 statements of topic position, and 1 statement of topic preparation content. More details can be seen in Table 4 below.

Table 4. Compatibility of the material with STEM

Sub component	Validator 1	Validator 2	Validator 3	Validation	Category
STEM structure	7.5	8.5	9.5	0.75	High
STEM definitions	7.5	8	9		
	7.5	9	9.3		
	7.5	8.5	8		
	2.5	9	9		
Topic position	5	9	9		
	7.5	9	8		
	5	9	9		
	5	9	8.5		
Topic preparation	5	8	7.5		

Based on Table 4 above, it can be concluded that the results of the validation of material conformity with STEM from the 3 validators obtained a score of 0.75 with the High category. Thus, the material used in the module is by the STEM material and the sub-components are

considered to meet the valid category because the material in the module developed is by the STEM model, which has defined science, technology, engineering, and mathematics. Furthermore, the explanation of global warming material has fulfilled STEM aspects such as science, explaining the concept of global warming; Mathematics, used to solve problems (global warming) related to numbers, calculations, and formulate relationships between variables and relate them to concepts (global warming); Technology, indicating technology that considers suitability to matter (global warming); Engineering, shows the process of designing, designing, structuring of technology. And the preparation of material has considered the STEM sequence to make it easier for students to understand global warming material.

In addition, the modules prepared already meet the characteristics of STEM learning materials. Broadly speaking, STEM-based modules are made based on their characteristics by the National Research Council (NRC) from 8 steps outline the application of science *and engineering* Bybee which include (1) asking questions and defining problems, (2) developing and using models, (3) planning and conducting investigations, (4) data analysis and interpretation, (5) developing mathematical and computational thinking, (6) building explanations and designing solutions, (7) engaging in argument from evidence, (8) obtaining, evaluating, and communicating information (Bybee, 2011).

The material in the STEM module is on the development of science and has used topics or case examples that are adapted to everyday life. This is in Rahdiyanta's opinion, one of the characteristics of the module is adaptive, that is, it can be adapted to the development of science and technology. It is said to be adaptive if the module can adjust to the development of science and technology and is flexible/flexible to be used in various hardware (Rahdiyanta, 2016). This indicates that the teaching materials prepared are by the demands of the curriculum and the materials used in the modules are by STEM materials on the topic of global warming. However, it still needs to be done some revisions with some suggestions given by validators to create modules that are suitable for use in learning.

b. The feasibility of teaching materials is divided into several assessments, namely

The teaching material feasibility instrument is divided into several sub-components namely, 2 attitude dimension statements, 3 knowledge dimension statements, 3 topic accuracy statements, 3 contextual statements, 2 law statements, and 3 skill statements. More details can be seen in Table 5 below:

Table 5. Eligibility of teaching materials

Sub component	Validator 1	Validator 2	Validator 3	Validation	Category
Attitude dimension				0.87	
	9	9	9		Very High
	5	9	9		
Knowledge dimension	8	10	9		
	8	10	8		
	7	10	10		
Topic accuracy	9	9	9		
	8	9	9		
	8	9	9		
Contextual	9	10	9		
	9	10	9		
	7	10	9		
Law	8	10	9		
	9	10	10		
Skill	8	9	8		
	9	9	9		
	5	9	9		

Based on Table 5 above, it can be concluded that the results of the validation of the feasibility of teaching materials from the 3 validators obtained a score of 0.87 with the Very High category. In the sub-component of the attitude dimension assessed, namely personal skills and social skills. Based on the results of data analysis, the module developed has presented a description of material and activities that can support the development of scientific attitude behavior such as curiosity, objective, responsible,

open, creative, innovative, caring attitude (cooperation, cooperation, tolerance, peace), politeness in appreciation for individual and group work, responsive and pro-active in solving social and environmental problems.

Based on the validation results, the material presented is by the learning objectives, includes all material contained in achievement competencies, the material is by facts and efficient to improve student understanding, reflects the description of the substance of the material contained in achievement competencies, and covers from the introduction of concepts to interactions between concepts that are arranged in sequence, material description, Examples, and exercises are presented relevant and can interest students' learning, the material or content or sentences contained in the module are original works and do not present something that discriminates. Rahdiyanta stated that one of the characteristics of the module is Self Contained, namely all learning materials contained in the module based on learning objectives (TP) and learning outcomes (CP) in the independent curriculum so that students can learn independently. In addition, students can learn thoroughly because the learning topic is packaged into a whole unit (Rahdiyanta, 2016). Because the module is by the feasibility component of teaching materials, the STEM-based module is said to be suitable for use for physics learning in class X with the topic of global warming.

c. Serving Components

The presentation component instrument is divided into several sub-components namely, 3 presentation statements, 6 topic presentation statements, 5 learning presentation statements, and 3 presentation statements of presentation. The scores given by each validator can be seen in Table 6 below:

Table 6. Serving components

Sub component	Validator 1	Validator 2	Validator 3	Validation	Category
Presentation	9	10	9	0.86	Very high
	8	9	9		
	7	9	9		
Topic presentation	9	9	9		
	5	10	9		
	8	9	10		
	1	9	10		
	8	9	10		
	9	9	9		
Learning presentation	8	9	9		
	7	10	10		
	9	9	9		
	7	10	9		
	9	10	9		
Presentation statements presentation	8	9	9		
	9	10	9		
	9	10	9		

Based on Table 6 above, it can be concluded that the results of the presentation component validation from the 3 validators obtained a score of 0.86 with the Very High category. This is because the presentation of modules is by deductive thinking (general to specific) or inductive (special to general), has been coherent in presenting material, and is coherent between concepts or between theories. Furthermore, the illustrations presented are appropriate and help students to understand the material being studied, have aroused student learning motivation, there is a summary or summary of the material, there are examples of questions that help strengthen students' understanding of concepts, modules can also be used by students anywhere and anytime. Rahdiyana stated that the characteristics of the modules that must be present are self-instructional and stand-alone. Self-instructional, namely modules can be used independently because several examples in it support the clarity of the material, exercises, and also tasks as a summary of the evaluation. Meanwhile, Stand Alone does not need additional references or books. In other words, it does not have to be used together with other teaching materials/media so that it is easy for students to learn (Rahdiyanta, 2016). Because the modules developed have met the valid requirements in the presentation component and meet the aspects

that have been described, the STEM module is suitable to be used for physics learning in class X with the topic of global warming

d. Language Component

The language component instrument is divided into 6 sub-components namely, according to the level of development, commutable dialogue, straightforwardness, coherence, KBBI, and the use of terms. There are 13 statements from the 6 sub-components. For more details about language instrument validation can be seen in Table 7 below.

Table 7. Linguistic component

Sub component	Validator 1	Validator 2	Validator 3	Validation	Category
According to the level of development	9	10	9	0.85	Very High
	8	10	9		
commutable dialogue	8	10	9		
	6	10	9		
	9	10	9		
Straightforwardness	8	10	9		
	8	9	9		
Coherence	1	9	9		
	7	10	9		
KBBI	8	10	9		
	8	9	9		
Use of terms	9	9	9		
	8	9	9		

Based on Table 7 above, it can be concluded that the results of the validation of the language component from the 3 validators obtained a score of 0.85 with the Very High category. This can happen because the modules developed already use grammar, good spelling, can explain the concepts of learning material so that it can be understood by students, encourage students to think creatively and motivate them, and sentence structure and standard terms are by the rules, have a coherent learning flow. Rahdiyana stated that one of the characteristics of the module that must exist is User-friendly, namely words built simply, understandably, clear sentences and terms, making it easier for users to access as desired (Rahdiyanta, 2016). Because the modules developed have met the valid requirements in the language component and meet the aspects that have been described, the STEM module is suitable to be used for physics learning in class X with the topic of global warming.

To create a good module, the module development process must pay attention to the characteristics needed by the module. The characteristics that must be fulfilled are Self-instructional*, Self Contained, Stand alone,* Adaptive, and User friendly (Rahdiyanta, 2016). The modules developed have fulfilled these characteristics, therefore the STEM modules developed are included in the category of good modules. Furthermore, based on the data from expert validation results in Table 4 to Table 7, it can be concluded that the modules developed are suitable for use. Module feasibility is reviewed from the indicators of material conformity with STEM, feasibility of teaching materials, presentation component, and language component.

This is supported by responses from students who state the module is good for use with an average of 69.30 in the medium category. Indicators of student response are learning, easy-to-understand learning material, motivation to learn, motivation to do problems, confidence and curiosity, self-efficacy, and module display. Almuharomah in his research stated that the STEM modules developed were suitable for use and received good student responses and students' creative thinking skills were known to increase after studying the module (Almuharomah et al., 2019; Utami et al., 2020)

Dissemination

This stage is the final stage of development research. The deployment stage is carried out to disseminate the product, which is in the form of a STEM-based physics module that has been developed. At this stage, the module will first be tested for readability to find out whether the language used in the preparation of the module can be understood or not. The readability test will be given to 3 students. The percentage of readability of students can be seen in the following Table 8:

Table 8. Recapitulation readability of Learners

Readability of Learners	Understand (%)	Do not Understand (%)
Readability of Learners 1	83	17
Readability of Learners 2	90	10
Readability of Learners 3	83	17
The Average Readability of Learners	86	14

In Table 8 it can be seen that overall 86% of students responded to understanding the content of the module and 14% of students responded not understanding. Student incomprehension includes less detailed instructions (page 7), difficult-to-understand explanations (page 11), more detailed explanations of CCUS (pages 18-19), IPO table lines are clarified (pages 22-23), and need more detailed explanations (page 25). From the results of the readability test, researchers will revise according to the suggestions and comments given by the three students. After the revision is carried out and declared suitable for use, the module will be field tested on research samples.

The display of STEM-based physics modules to train students' STEM literacy that has been developed is presented in Figure 3 as follows.

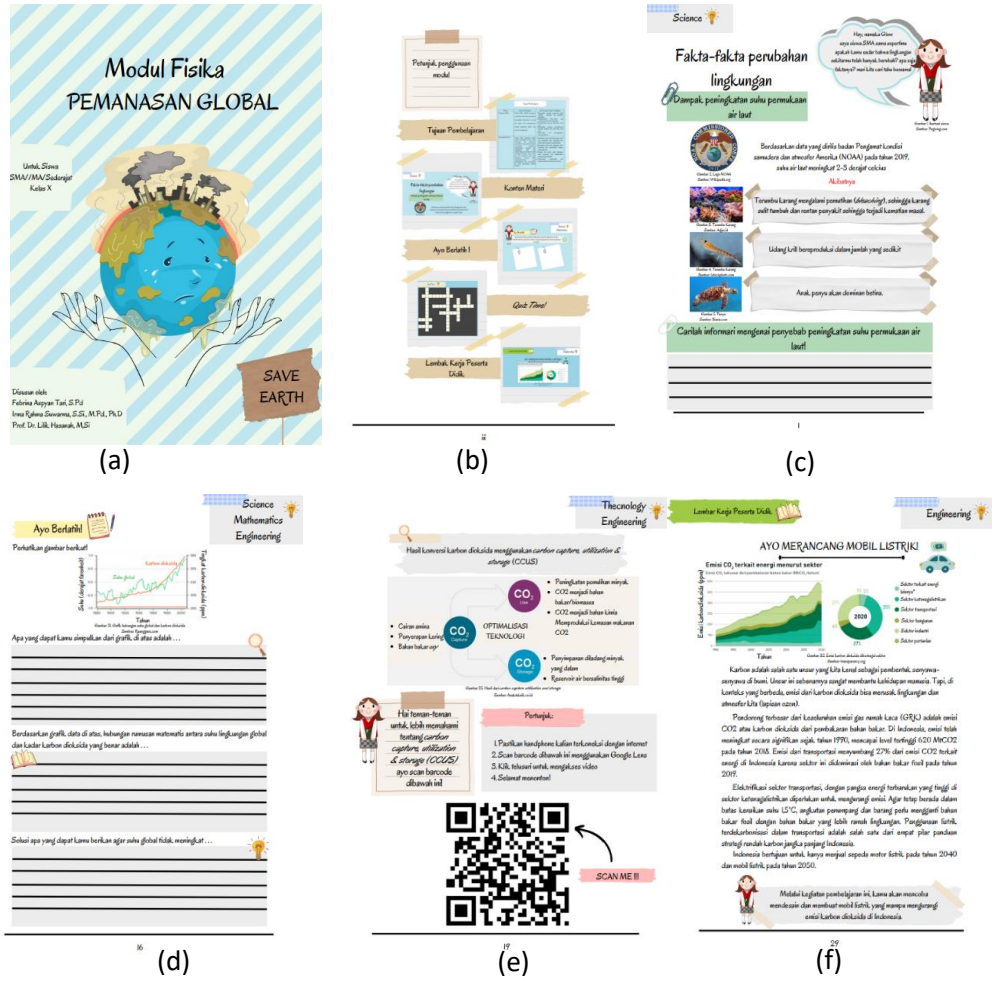

Figure 3. Displays of STEM-Based physics module, (a) Cover (b) Intruction (c) Content (d) Exercise (e) QR Code integrated learning video (f) Worksheets

The modules developed will be printed to make it easier for students to learn the module because one of the reasons researchers choose the printed module is the unstable internet network in the school. Modules were printed in 36 duplicates, then distributed to students, and carried out learning for several meetings. In the module there is also an LKPD that requires students to design electric cars using solar panels, then the design will be tested and completed.

The effectiveness of using STEM-based modules on students' STEM literacy is measured by questionnaires of students' responses to modules that have been developed. During the learning process, teachers only use STEM-based physics modules. The content of the module is designed so that students can easily understand the material and can practice their learning skills, especially students' STEM literacy skills. After the entire learning process ends and all global warming material is delivered, students will be given a questionnaire to find out their responses or responses to the modules that have been studied. The process of distributing questionnaires is carried out online using the help of google forms, where teachers provide links to students so that they can fill out the questionnaire. Each student is only given one opportunity to answer the questions given by the teacher. There are 30 questions given to students through the Google form. The 30 questions are divided into 8 aspects, namely: love to learn, easy to understand the subject matter, motivated to learn, motivated to do the problem, confidence and curiosity, mutual respect, and module display. The following is a recapitulation of students' perceptions of STEM-based physics modules.

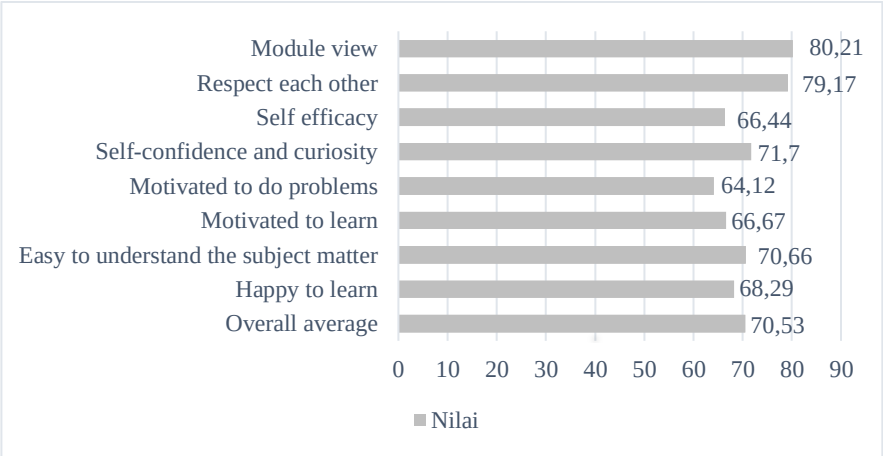

Figure 4. Recapitulation of Learners' perceptions

Based on Figure 12 shows a recapitulation of students' perceptions obtained from the average of each aspect. The figure above shows that the average perception of students towards the use of modules in the overall learning process is 70.53 in the medium category. Thus, it can be said that there is a positive attitude shown by students in the use of these modules during the physics learning process on the topic of global warming. Of the 8 aspects of student response, the module display aspect occupies the highest score with an average of 80.21 high categories while the lowest aspect is occupied by the motivated aspect to do questions with an average of 64.12 medium categories. Thus, it can be said that students are interested in the appearance of the module and are satisfied with the appearance of the module but the motivation of students in doing the questions is still less than other aspects.

The lack of motivation of students in doing questions can be caused by several factors that can be caused as too many questions that must be filled in by students in the module, lack of time in working on the questions, and the ability of students to solve the questions. Furthermore, Ridwan stated that the factors that affect the ability of students to solve physics problems include teacher behavior factors during the learning process that are lacking in guiding students in working on problems and giving questions to students which are mostly only one indicator of scientific literacy aspects, factors of student interest that are lacking, factors of student learning habits when given assignments only (Irwan, 2020). The cause of the difficulties experienced by

students in answering essay questions is that students do not understand the problem, students have difficulty in applying a concept, and students have difficulty understanding what is known and what is asked in the question in narrative form (Hidayatulloh, 2020). The ability of students to solve cognitive problems of the type of analyzing and evaluating in physics subjects is included in the criteria of less and less (Wijaya et al., 2019). Furthermore, Nabilah, et al in their research stated that the cognitive ability of class students to solve physics problems was moderate (Nabilah et al., 2020).

Furthermore, the other highest assessments sequentially were on the indicator of mutual respect with an average of 79.17 high categories, indicators of confidence and curiosity with 71.7 medium categories, indicators of easy understanding of learning material with 70.66 medium categories, indicators of happy learning with 68.29 medium categories, indicators of motivation to learn of 66.67, and indicators of self-efficacy of 66.44 medium categories.

In general, students' perceptions on the development of STEM-based physics modules to train students' STEM literacy for each aspect or indicator in the medium category. In other words, the modules developed can be well received by students as one of the learning media for physics. Based on the results of perception, e-modules based on scientific approaches developed are categorized as very good and very well used to support physics learning (Anggraini, 2017). Student perceptions of physics learning modules on Static Fluid material using this STEM approach obtain very good categories so that they can be used as supporting learning resources to help the learning process (Reiza, n.d.)

CONCLUSION

Based on the results of the study, it can be concluded that the STEM-based modules developed are suitable for use in the learning process. The feasibility is based on aspects of material suitability with STEM (science, technology, engineering, and mathematics) with a validation score of 0.75 in the high category (feasible).

Furthermore, aspects of the feasibility of teaching materials are divided into several assessments, namely the attitude dimension, knowledge dimension, and material accuracy with a score of 0.87 in the very high category (very feasible), module design with a score of 0.86 in the very high category (very feasible) and the language component with a score of 0.85 in the very high category (very feasible). Overall, 86% of students responded to understanding the content of the module and 14% of students responded not understand the module readability questionnaire.

The effectiveness of using STEM-based modules on global warming material in training students' STEM literacy skills is measured by questionnaires of students' responses to modules that have been developed. The average perception of students towards the use of modules in the overall learning process is 70.53 in the medium category. Thus, it can be said that there is a positive attitude shown by students in the use of these modules during the physics learning process on the topic of global warming.

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