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DEVELOPMENT OF STEM-BASED E-MODULES USING FLIP PDF PROFESSIONAL ON TEMPERATURE AND HEAT MATERIL

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Abstract :
This research aims to produce a STEM-based e-module on temperature and heat material and determine student perceptions. This research is development research that uses the ADDIE model, which consists of analysis, design, development, implementation, and evaluation. However, this research is limited to the implementation stage. The test subjects for this research were class XI MIPA 6 students at Senior High School 3 Jambi City and class XI MIPA 3 students at Senior High School 11 Jambi City. The instruments used were media and material validation questionnaires and student perception questionnaires. Two types of data are collected, namely qualitative and quantitative. Qualitative data was obtained from media and material experts' criticism, comments, and suggestions. Then, quantitative data was obtained from the results of product validation by validation by media and material experts, as well as student perception questionnaires. The results of media expert validation by the two validators were 100% in the very good category. The results of material validation by the two validators were 70.83% in the good category and 97% in the very good category. The results of the analysis of student perceptions obtained an average score from the two schools, namely 84.05% and 86.97% in the very good category. The STEM-based electronic modules developed are valid and suitable for use to help students in the learning process, and the e-modules developed can be accessed offline via laptop/computer and online via cellphone by distributing links to students.

Keywords: E-Module; STEM; Temperature and Heat

INTRODUCTION

Education is capital to determine the direction of a nation to become better and determine the development or progress of a nation. In this way, education can make all unknown things known, because education can be used as a means for individuals to obtain a broad source of knowledge, such as those related to nature and life (Alwan et al., 2017). Education is very important for us both as pupils, students, parents and others (Azriyani, 2021). This is in line with research (Joneska et al., 2016) which

states that education plays a very important role in efforts to improve the quality of human resources and the survival of a nation both now and in the future. This aims to obtain advanced, creative and independent humans, as well as adapting to advances in science and technology. Therefore, improving the quality of education is a major concern for teachers, parents, society, government and students themselves.

Physics is a branch of science that has a very important role in education. According to Fitri et al. (2019) physics is a part of science, studying physics is not just about knowing mathematics, but furthermore students are expected to be able to solve problems faced in everyday life. One of the materials in physics that is important to study is temperature and heat. Temperature and heat are physics subjects in class XI in the odd semester in the 2013 curriculum and even semester in the independent curriculum.

Learning is essentially a process of interaction and communication between teachers and students. The learning process plays an important role in supporting student learning outcomes and goals, so the quality of the learning process really needs to be paid attention to. The availability of adequate teaching materials in accordance with developments in science and technology is very important for students in learning (Arnila et al., 2021). Teaching materials are the most important part in the implementation of education, because with teaching materials students will be helped and find it easier to learn and teachers will find it easier to teach. The form of teaching materials varies according to certain needs and characteristics depending on the subjects contained in the curriculum or syllabus (Agustina, 2018).

21st century skills are one of the most important skills that students must master to face future challenges (Asrizal et al., 2023). Chalkiadaki (2018) also said that 21st century skills are important for students with the goal of academic and life success in the future. According to Afif et al. (2021) 21st century skills consist of 6C, namely Critical Thinking, Creativity, Communication, Citizenship, Character, Collaboration. One part of 21st century skills is Collaboration. Collaboration skills are very important in classroom activities because they can increase students' knowledge in achieving learning goals. Groups of students working collaboratively will produce more knowledge (Ulhusna et al., 2020). The advantages of learning with the ultimate goal of collaboration are: practicing effective division of labor; increasing the character of student responsibility, combining information from various sources of knowledge, perspectives, experiences; and increased creativity and quality of solutions stimulated by the ideas of members in each group (Child, 2016; Dooley & Sexton-Finck, 2017).

Based on the explanation above, it can be seen that the importance of teaching materials in learning physics. However, the real conditions in the field do not match the expected conditions. This is proven from initial observations carried out at Senior High School 3 Jambi City and Senior High School 11 Jambi City by means of interviews with physics teachers and several students. The teacher stated that the teaching materials used still used printed teaching materials, namely textbooks published by Marthen Kanginan and Yrama Widya, sometimes also using printed modules. The teacher also stated that students' collaboration skills in learning were still in the low category. Then the obstacles that teachers face when teaching temperature and heat material are in the black principle material section due to students' lack of mastery of concepts and mathematics in this material. Meanwhile, students stated that the material on temperature and heat was also difficult to understand.

One solution to overcome the problems above is to develop teaching materials in electronic form such as STEM-based e-modules to face 21st century learning. Electronic modules are a new innovation in the world of 21st century education and electronic modules are also one of the most effective teaching materials in online or independent learning (Rasmi et al., 2023). According to Laili et al. (2019) electronic modules can also display text, images, animations or videos and the use of these electronic modules is not limited to place and time, depending on the student's ability to use them. Then the e-module also has an interactive nature that makes navigation easier, and is equipped with formative tests/quizzes (Sugihartini & Jayanta, 2017).

One approach that is suitable to be applied to e-modules is the STEM approach. learning with a STEM (Science, Technology, Engineering, and Mathematics) approach is the right learning to be applied in accordance with developments in the 21st century. STEM is learning with an approach that integrates science, technology, engineering and mathematics by focusing on solving real problems in everyday life -day (Siswanto, 2018). STEM is oriented towards solving real problems faced with the

aim of giving students practice in finding innovative solutions (Zulaiha & Kusuma, 2020). STEM has three approaches to the learning process, the difference between the three lies in the level of the STEM components applied. Three educational approaches that are often used are the "silo" (separate), "embedded" approach, and the "integrated" approach (Zulaiha & Kusuma, 2020). In its application the STEM approach does not only focus on cognitive development, but also in effective development, because STEM education provides opportunities for students to be active in learning by working together, being disciplined, helping each other so that the STEM approach is suitable in the formation and development of knowledge aspects (cognitive), attitude aspects (effective) and skills aspects (psychomotor) (Sartika, 2019).

Research that is relevant to this research is research conducted by Syahiddah et al. (2012) where the similarity between this research and the research to be carried out is that they are both developing STEM-based e-modules. The difference is that in this research the e-module was developed on sound material, while the research was carried out on temperature and heat material. Then this research uses the anyflip application, while the research that will be carried out uses the Flip PDF Professional application. Another study by Arnila et al. (2021) where the similarity between this research and the research to be carried out is that they are both developing STEM-based e-modules. The difference is that this research uses static fluid and dynamic fluid materials, while the research used uses temperature and heat materials. The drawback is that research is only carried out up to the expert validation stage, which is different from research carried out by researchers up to the student perception stage. Research by Maiyena et al. (2020) where the similarity with the research to be carried out is that they are both developing teaching materials in the form of electronic physics modules. This development is not integrated with STEM, while the development carried out by researchers is in the form of STEM-based electronic modules. Then research by Sriwahyuni et al. (2019) where the similarity with the research to be carried out is that they are both developing electronic teaching materials using the Flip PDF Professional application. The advantage of the development carried out by researchers is that this development is not integrated into STEM, while the development carried out by researchers is integrated into STEM. And the material is also different, in this research the materials used were optical instruments, whereas in the research carried out by the researchers the materials were temperature and heat. Furthermore, research by Nurhayati et al. (2019) where the similarity between this research and the research to be carried out is that they both aim to improve students' collaboration abilities. The advantage of the research that will be carried out by researchers is to develop electronic teaching materials

This research aims to produce a valid STEM-based e-module on temperature and heat as a support for physics learning and to determine students' perceptions of the electronic module.

RESEARCH METHOD

The type of research used is research and development. According to Purwanti (2015) development research is a research method used to produce certain products, and test the effectiveness of these products using needs analysis research so that they can function in the wider community. The development model used in this research is the ADDIE model. According to Barokati & Annas (2013) the ADDIE model stands for Analysis, Design, Development, Implementation, Evaluation which was developed by Raiser and Mollenda in the 1990s.

The research was carried out at Senior High School 3 Jambi City on January 31 2022 and at Senior High School 6 Jambi City on February 9 2022. The subjects of this research consisted of class XI MIPA 6 students at Senior High School 3 Jambi City and class XI MIPA 3 students at Senior High School 11 Jambi City.

The development procedures in this research are in accordance with the model used, namely the ADDIE model which consists of five procedures, namely analysis, design, development, implementation, evaluation. The development research carried out by researchers only reached the implementation stage, namely implementation in small groups.

The first stage, namely analysis, aims to collect information or data regarding the need for development to be carried out. The analysis stage consists of needs analysis, student analysis and learning environment. This analysis stage was carried out by interviewing teachers and students. After carrying out the initial analysis stage, the researcher continued to the design stage. According to Rusdi

(2018), the design stage consists of determining the development team, determining the resources needed, compiling a development schedule, determining the scope of learning, creating a storyboard, determining product specifications, and creating a product prototype.

Next, the development stage was carried out, namely media and material validation was carried out by 3 physics education lecturers from Jambi University and Jakarta State University in order to assess the product from the media and material aspects. So, the shortcomings or weaknesses of the product will be known. Validation is carried out continuously until an e-module is obtained that is really good and suitable to proceed to the implementation stage. The implementation phase carried out small group trials, small group trials were carried out on users who had used STEM-based electronic modules on temperature and heat material. Then the user was given a perception questionnaire about the product, then the researchers analyzed the data from the user perception questionnaire.

Data collection instruments are tools used to collect research data (Juliandi et al, 2014). Data collection instruments in this research were interview sheets, media expert and material expert validation sheets, and student perception questionnaires. The media expert validation questionnaire instrument grid used in developing the e-module is as shown in Table 1.

Table 1. Media Validation Instrument Grid

Assessment Aspects	Number of Items	Item Number
E-module cover design	4	1,2,3,4
Design e-module content	7	5,6,7,8,9,10,11
E-module software design	2	12,13
Presentation Components	5	14,15,16,17,18

(Arnila, 2021)

The material expert validation questionnaire instrument grid used in e-module development is as shown in Table 2.

Table 2. Material Expert Validation Instrument Grid

Assessment Aspects	Number of Items	Item Number
Accuracy of content	2	1,2
Accuracy of content coverage	3	3,4,5
Digestibility of contents	3	6,7,8
Language	2	9,10
Components of the STEM framework	3	11,12,13

(Reiza, 2020)

The student perception questionnaire instrument grid used in developing the e-module is as shown in Table 3.

Table 3. Student Perception Instrument Grid

Assessment Aspects	Number of Items	Item Number
Language use	3	1,2,3
Appearance	3	4,5,6
Attractiveness	4	7,8,9,10
Components of a STEM Framework	6	11,12,13,14,15,16

(Reiza, 2020)

There are two types of data collected, namely qualitative data and quantitative data. Qualitative data was obtained from criticism, comments and suggestions provided by media experts and material experts. Then quantitative data was obtained from the results of product validation by validation by media and material experts, as well as a student perception questionnaire with several alternative answer choices according to a Likert scale with the highest score being 4 and the lowest score being 1. The total score results were then calculated using the formula:

$$P = \frac{n}{N} \times 100\%$$

With:
P = Percentage
n = total score
N = maximum score

After the data is analyzed, the data is then interpreted to obtain conclusions regarding the development of STEM-based electronic modules (e-modules) using professional flip pdf on Temperature and Heat material in the categories of very good, good, not good, or very bad. The percentage score classification can be seen in Table 4.

Table 4. Percentage Score Classification

Percentage	Score Category
0 – 25 %	Very Not Good
26 – 50 %	Not good
51 – 75 %	Good
76 – 100 %	Very good

After the data results are classified based on table 4, conclusions can be obtained from the development of a professional STEM-based flip pdf electronic module (e-module) on Temperature and Heat material.

RESULTS AND DISCUSSION

The development model used in this research is the ADDIE model consisting of analysis, design, development, implementation and evaluation. This research was limited to the implementation stage, namely small group trials in class XI MIPA 6 at Senior High School 3 Jambi City and class XI MIPA 3 at Senior High School 11 Jambi City. The analysis stage is the initial stage in developing STEM-based electronic modules on temperature and heat. Analysis is carried out to identify the facts that exist in the learning process and recommend solutions that are appropriate to existing conditions. The analysis stages carried out are needs analysis, student analysis, and learning environment analysis. Next was the design stage, where the researcher designed the product being developed, namely a STEM-based e-module using professional pdf flip on temperature and heat material for high school class XI.

After the product is designed, it continues to the development stage which aims to produce teaching materials in the form of physics e-modules. This development consists of activities to create, provide and modify e-modules to achieve predetermined goals. At the development stage, media and material expert validation is carried out. validation carried out by 2 lecturers, namely physics education lecturers at Jambi University and Jakarta State University to see whether the e-module being developed is suitable for use or not. Validators who are media and material experts will provide suggestions, opinions, input and critical assessments of the development of the electronic module which was developed.

The media expert validator assessment consists of four aspects, namely e-module cover design, e-module content design, e-module software design, and presentation components. The media expert validation process was carried out twice by validator I and once by validator II. The following are the results of stage I media expert validation by validator I.

Table 5. Results of Phase I Media Expert Validation by Validator I

No	Indicator	Average	Category
1	E-module cover design	62.5%	Good
2	Design e-module content	64.28%	Good
3	E-module software design	75%	Good
4	Presentation Components	70%	Good
	Average	66.67 %	Good

Based on table 5, the average results obtained for the e-module cover design indicator were 62.5% in the good category, the e-module content design was 64.28% in the good category, the e-module software design obtained an average value of 75% in the good category. good, and the presentation component indicators obtained an average value of 70%. So the average value of the five indicators is 66.7% in the good category. However, there are still suggestions and improvements from the validator, including strengthening color contrast, improving the font style, and making the material layout clearer. After the e-module was revised, a second validation was carried out by validator I. The validation results can be seen in Table 6.

Table 6. Results of Phase II Media Expert Validation by Validator I

No	Indicator	Average	Category
1	E-module cover design	100 %	Very good
2	Design e-module content	100 %	Very good
3	E-module software design	100 %	Very good
4	Presentation Components	100 %	Very good
	Average	100 %	Very good

Based on panel 6, the average of the four indicators is 100% in the very good category. Based on the results of stage II media validation data analysis by validator I, it shows that the development of a STEM-based e-module using Flip PDF Professional on temperature and heat material is feasible for implementation. Next, phase I media expert validation was carried out by validator II, the results of which can be seen in Table 7.

Table 7. Results of Phase I Media Expert Validation by Validator II

No	Indicator	Average	Category
1	E-module cover design	100 %	Very good
2	Design e-module content	100 %	Very good
3	E-module software design	100 %	Very good
4	Presentation Components	100 %	Very good
	Average	100 %	Very good

Based on the results in table 7, the results of stage I media validation by validator II were obtained with an average percentage of 100% in the very good category. The results of stage I media validation data analysis by validator II are the same as the results of stage II media validation data analysis by validator I which shows that the development of STEM-based e-modules using Flip PDF Professional on temperature and heat material is feasible to be implemented

Then the material expert validator's assessment consists of five aspects, namely accuracy of content, accuracy of content coverage, digestibility of content, language, and components of the STEM framework. The material expert validation process was carried out once by validator I and twice by validator II. The following are the results of stage I material expert validation by validator I.

Table 8. Results of Stage I Material Expert Validation by Validator I

No	Indicator	Average	Category
1	Accuracy of content	75 %	Good
2	Accuracy of content coverage	75 %	Good
3	Digestibility of contents	60.71 %	Good
4	Language	75 %	Good
5	Components of a STEM framework	62.5 %	Good
	Average	70.83 %	Good

Based on table 8, the results of material validation by validator I obtained on the indicators of content accuracy, content coverage and language, an average percentage of 75% in the good category, on the content digestibility indicator, an average percentage of 60.71% was obtained in the good category, and the components were The STEM framework components obtained an average percentage

of 62.5% in the good category. So the average percentage of the five indicators is 70.83% in the good category. The suggestions and input from validator I are to add projects to the e-module being developed. Furthermore, the validation data for stage I by validator II can be seen in table 9.

Table 9. Results of Stage I Material Expert Validation by Validator II

No	Indicator	Average	Category
1	Accuracy of content	75 %	Good
2	Accuracy of content coverage	65 %	Good
3	Digestibility of contents	67,86 %	Good
4	Language	70 %	Good
5	Components of a STEM framework	62.5 %	Good
	Average	66.67 %	Good

Based on table 9, it shows that the results of stage I validation by validator II on the content accuracy indicator obtained an average percentage of 75% in the good category, accuracy of content coverage obtained an average percentage of 65%, digestibility obtained an average percentage of 67.86%, language 70%, and indicators of STEM framework components 62.5%. So the average of these five indicators is 66.67% in the good category. However, there are still suggestions from validators, namely clarifying the STEM elements in the material, adding independent practice questions, and improving the material according to suggestions. After the e-module has been revised, stage II validation is carried out by validator II. The validation results can be seen in table 10.

Table 10. Results of Stage II Material Expert Validation by Validator II

No	Indicator	Average	Category
1	Accuracy of content	100 %	Very Good
2	Accuracy of content coverage	100 %	Very Good
3	Digestibility of contents	92.86 %	Very Good
4	Language	100 %	Very Good
5	Components of a STEM framework	95.83 %	Very Good
	Average	97 %	Very Good

From table 10, it shows that the results of stage II validation by validator II on indicators of accuracy of content, accuracy of content coverage, and linguistics obtained an average percentage of 100% with the very good category, the digestibility indicator was 92.86% with the very good category, and for the components- STEM framework components 95.83% with very good category. The average percentage result for the five indicators is 97% in the good category. Based on the results of data analysis of stage II material validation by validator II, it shows that the development of a STEM-based e-module using Flip PDF Professional on temperature and heat material is feasible for implementation.

The following are the results of the product in the form of an e-module which has been declared suitable for testing.

Figure 1. E-Module Cover

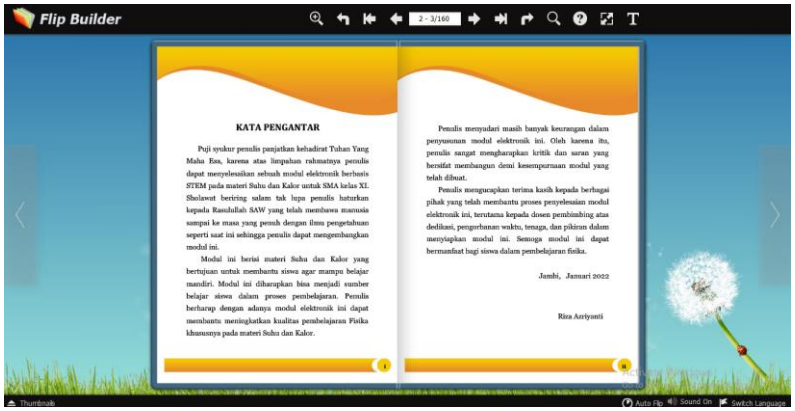

Figure 2. E-Module Preface

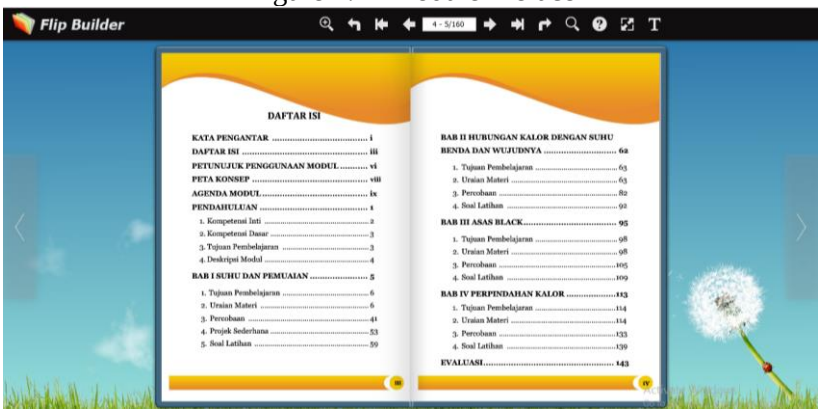

Figure 3. E-module Table of Contents

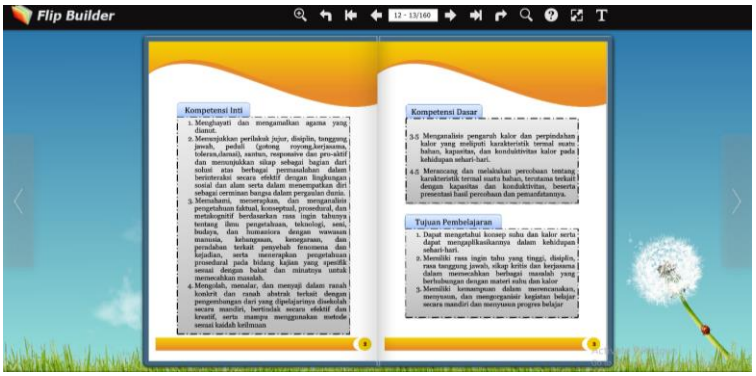

Figure 4. Introduction to E-Module

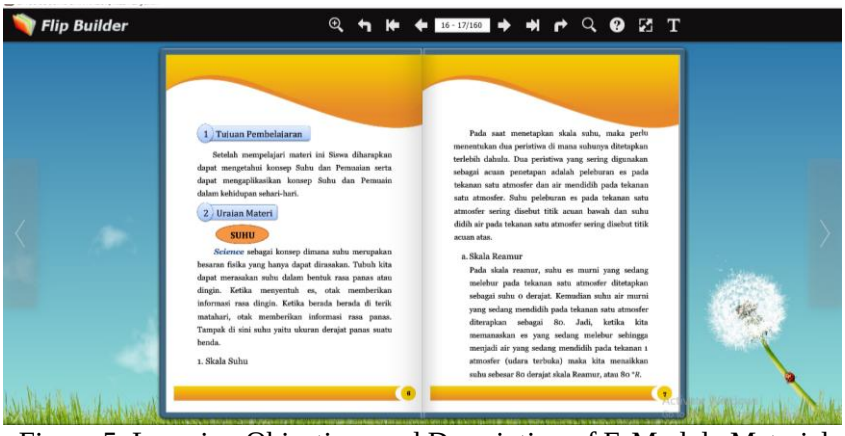

Figure 5. Learning Objectives and Description of E-Module Material

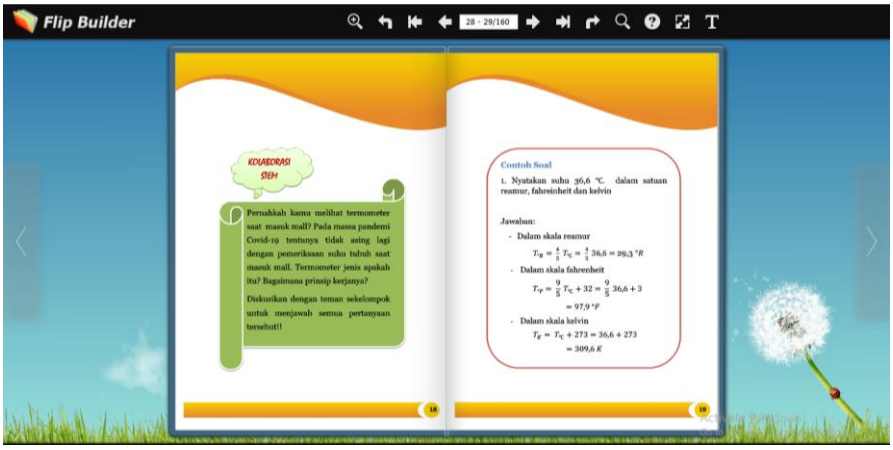

Figure 6. STEM Collaboration and Example Questions

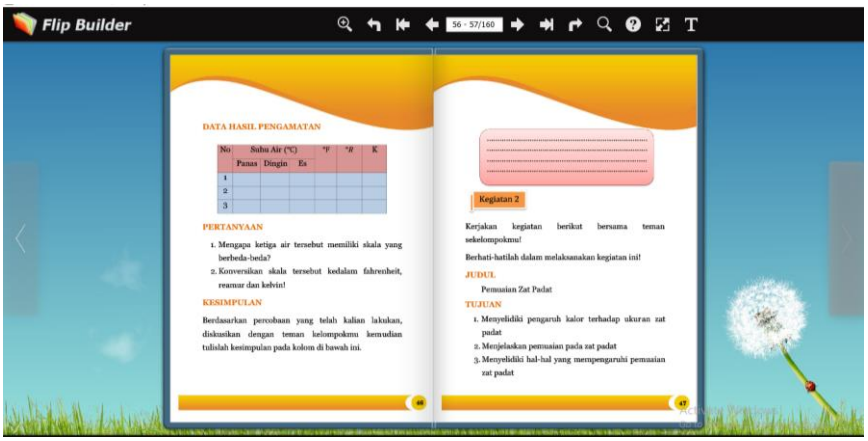

Figure 7. Experiment on E-Module

Figure 8. Simple Project on E-Module

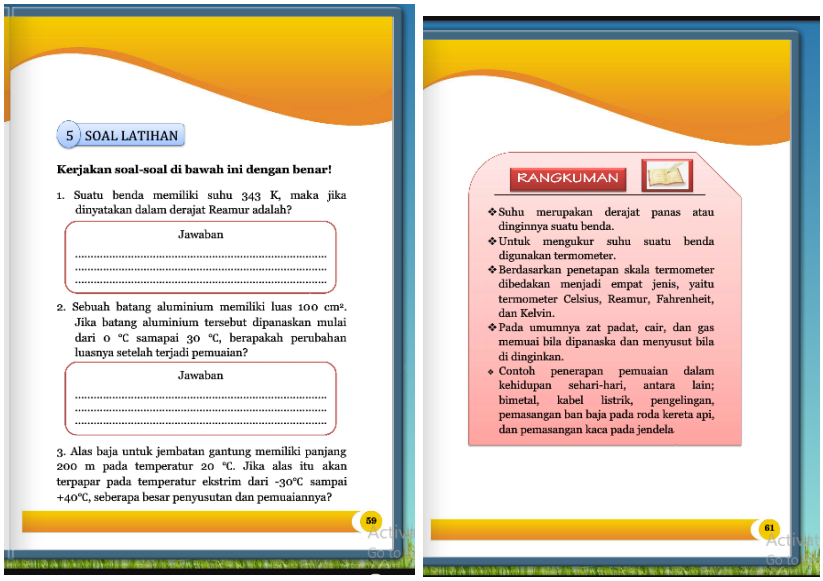

Figure 9. Practice questions and summary

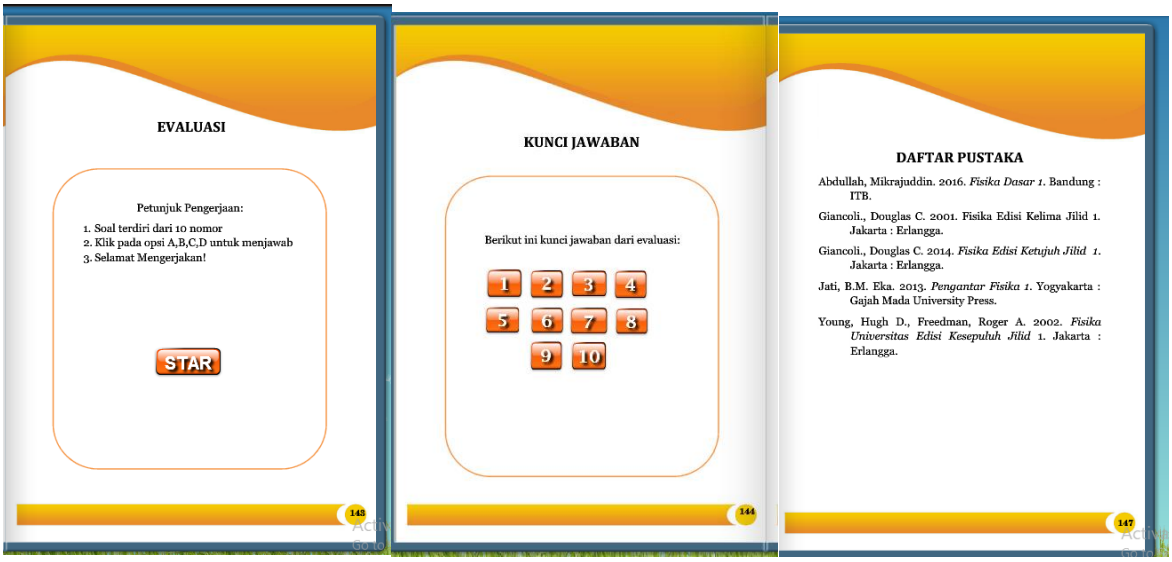

Figure 10. Evaluation, Answer Key and Bibliography

After the product has been validated, it is then improved according to suggestions, criticism and input from media experts and material experts and the product results are in the very good or very valid category. Then we enter the fifth stage, namely the implementation of STEM-based e-module products using Flip PDF Professional on temperature and heat material by testing it on small groups, namely 15 students at Senior High School 3 Jambi City and 15 students at Senior High School 11 Jambi City as test subjects. try. Small group trials were carried out by students using STEM-based e-module products on temperature and heat material that had been developed. Next, students were given a perception questionnaire to see students' perceptions as users regarding the use of STEM-based e-module products on the temperature and heat material that had been developed.

There are four aspects of assessment in the student perception questionnaire towards STEM-based e-modules using Flip PDF Professional on temperature and heat material, namely aspects of language use, aspects of appearance, aspects of attractiveness, and aspects of the components of the STEM framework. The results of student perceptions at Senior High Scool 3 Jambi City can be seen in Figure 11.

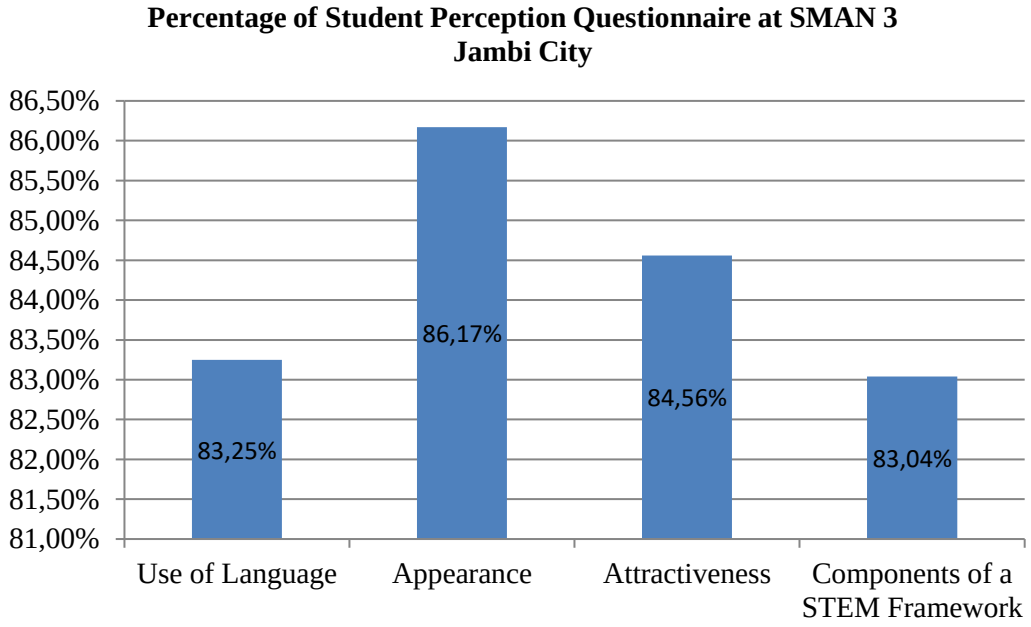

Figure 11. Average percentage of student perception questionnaires at Senior High Scool Jambi City

Based on Figure 11, it can be seen that the perception of students at Senior High Scool 3 Jambi City in the aspect of language use is an average percentage of 83.25% in the very good category, in the aspect of appearance the average percentage is 86.17% in the very good category, in the aspect of attractiveness the percentage an average of 84.56% in the very good category, and in the aspect of STEM work components the average percentage was 83.04% in the very good category. It can be seen below that the facial aspect is the aspect with the highest percentage compared to other aspects. From the four assessment aspects, the average percentage of students' perceptions of STEM-based e-modules on temperature and heat material at Senior High School 3 Jambi City was 84.05% with a very good category. So that STEM-based e-modules using Flip PDF Professional on temperature and heat material are suitable for use to help students in the learning process.

Furthermore, the percentage per aspect of the results of the student perception questionnaire at Senior High School 11 Jambi City regarding STEM-based e-modules can be seen in Figure 12.

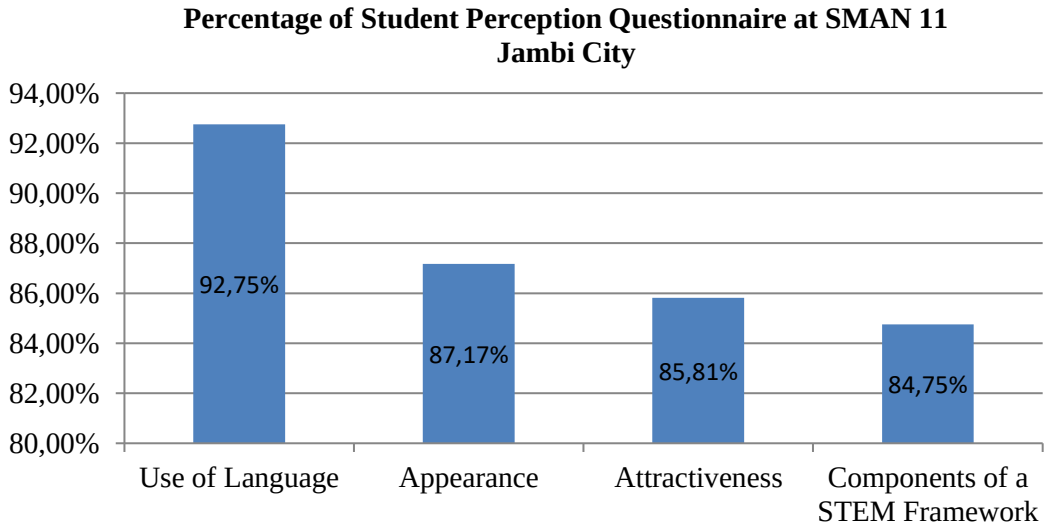

Figure 12. Average percentage of student perception questionnaires at Senior High School 11 Jambi City

Based on Figure 12, it can be seen that the perceptions of Senior High School 11 Jambi City students regarding aspects of language use, appearance, attractiveness, and components of the STEM framework have an average percentage of 92.75%, 87.17%, 85.81 respectively. %, and 84.75% which is in the very good category. Apart from that, it can be seen that the aspect of language use is the aspect with the highest percentage compared to other aspects. From these four assessment aspects, the average percentage of students' perceptions of STEM-based e-modules on temperature and heat material at Senior High School 11 Jambi City was 86.97% with a very good category. So that STEM-based e-modules using Flip PDF Professional on temperature and heat materi

Good teaching materials can facilitate students to get to know the natural surroundings better (Chen & Xiao, 2021). Therefore, the presentation of material is said to be good if the teaching materials used are valid and suitable for use. This is in line with research (Chen & Srimadona, 2023) that the development of electronic modules using professional pdf flip on measurement material is valid and suitable for use by students. Another research by (Wati & Syafriani, 2023) states that the E-module based on an inquiry model integrated with the SETS approach is suitable for use as teaching material for mechanical waves, traveling waves and stationary waves in mechanical waves subjects for class XI MIPA senior high school. Relevant research by (Marnah et al., 2022) states that the multi-representation based physics learning module is valid and can be used to determine the increase in problem solving abilities in schools. Research by (Mutmainah et al., 2022) states that STEM-based physics teaching materials developed for high school students are categorized as very valid

21st century learning is learning that integrates literacy abilities, knowledge skills, skills and attitudes, as well as mastery of technology. According to Tjahjani et al. (2020) 21st century skills consist of 6C, namely Critical Thinking, Creativity, Communication, Citizenship, Character, Collaboration. One part of 21st century skills is Collaboration. Collaborative learning is a form of K13 learning, where collaboration is cooperation or helping each other carried out by students to achieve the same goal. There is collaboration so that students can manage groups, solve problems together, and overcome differences that occur within the group. Collaborative learning places more emphasis on intellectual problem solving and developing social aspects. Students depend on each other and working together is mutually beneficial. In practice or application, collaborative learning carried out in schools is more concerned with ordinary group work whose members do not depend on each other (Zainuddin, 2017).

E-Modules are a new innovation in the world of education in the 21st century and are one of the effective teaching materials for online learning, because with E-Modules students can study independently at home, can work on questions and activities contained in the modules. especially in physics subjects. Apart from that, according to Laili et al. (2019) electronic modules can also display text, images, animations or videos and the use of these electronic modules is not limited to place and time, depending on the student's ability to use them.

This e-Module is used as teaching material, whether studying independently or with guidance from a teacher (Priatna et al., 2017). Meanwhile, according to Perdana et al. (2017) electronic modules are independent learning materials or materials that are arranged systematically in the smallest learning units to achieve certain learning objectives in electronic format which includes animation, audio, navigation which makes users more interactive with the program. Electronic modules (e-modules) are almost the same as e-books, the only difference is in the contents of the two. Encyclopedia Britannica Ultimate Reference Suite explains that e-books are digital files that contain text and images that are suitable for distribution electronically and displayed on a monitor screen similar to printed books. E-modules or electronic modules are modules in digital form consisting of text, images or both accompanied by simulations that can be used in learning (Herawati & Muhtadi, 2018).

According to Siswanto (2018) learning with a STEM (Science, Technology, Engineering, and Mathematics) approach is the right learning to be applied in accordance with developments in the 21st century. STEM is learning with an approach that integrates science, technology, engineering and mathematics by focusing on problem solving real in everyday life. STEM learning is one of the higher level learning that creates. STEM learning can increase students' learning motivation because students are directly involved in the learning process and create a generation that likes learning science and mathematics. Through STEM learning, students are required to solve problems, be innovators, build independence, think logically, understand technology, and be able to connect STEM education with the real world (Artobatama et al., 2020).

The limitations of this research are developing modules in electronic form that can be used with cellphones or computers/laptops, choosing STEM (Science, Technology, Engineering, and Mathematics) based learning which is used to develop e-modules, choosing temperature and heat material which is then developed into e-module teaching materials, and the development of this e-module uses the ADDIE development design model which is limited to the implementation stage, namely testing in small groups.

CONCLUSION

The development results obtained are in the form of STEM-based e-modules that are valid and can be accessed online or offline via cellphone, laptop or computer. Validation is carried out by media and material experts. The results of media expert validation by the two validators were 100% in the very good category. The results of material validation by the two validators were 70.83% in the good category and 97% in the very good category. Then the results of material expert validation by the two validators were 70.83% in the good category and 97% in the very good category. After validation was carried out by media and material experts, student perception questionnaires were then distributed in two schools. The results of students' perceptions of the e-modules developed from the two schools were obtained with an average score of 84.05% and 86.97% in the very good category. So that the STEM-based e-module using professional flip pdf on temperature and heat material for high school class XI is valid and suitable for use to help students in the learning process.

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