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ORIGINAL RESEARCH

Development of an Integrated Temperature & Heat E-module for Forest and Land Fire Mitigation to Improve the Analytical Skills of Grade VII Students

Rika Anggraini, Sugiarti, Sulistiawati

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Abstract

The frequent forest and land fires in South Sumatra have a significant impact on the environment and society, both caused by internal and external factors. Therefore, disaster mitigation learning is crucial, especially in disaster-prone areas. This learning can be integrated into the school curriculum to help students understand how to deal with and reduce disaster risks. One effective teaching material is an interactive and engaging e-module, making it easier for students to understand the concepts of mitigation and science simultaneously. The purpose of this study is to develop a valid, practical, and effective e-module to improve students' analytical skills and raise their awareness of caring for the environment and the surrounding nature. This study uses the ADDIE method (Analyze, Design, Development, and Evaluation). The evaluation stage follows Tessmer formative evaluation, which consists of self-evaluation, expert validation, one-to-one, small group, and pretest-posttest. The product validation results show that the developed e-module is very valid, with an average expert assessment of 4.30. The practicality test shows that the e-module is very practical, with an overall percentage of 88%. Meanwhile, the N-gain test obtained a score of 0.59 which is classified as quite effective. In terms of students' cognitive levels at the level of understanding (C2), application (C3), and analysis (C4), the e-module resulted in an increase in pre-test scores (30.33) and post-test scores (71.53). The integrated temperature and heat e-module for forest and land fire disaster mitigation can function as an alternative learning resource that can be accessed at school, at home, or in other locations.

Keywords: E-module · Temperature & Heat · Analytical Capabilities

INTRODUCTION

South Sumatra is one of the areas prone to forest and land fires due to its extensive peatland (Budiningsih, 2017). The peak of the largest fires occurred in In 2015, fires in South Sumatra province, according to the Regional Disaster Management Agency (BPBD), destroyed 736,570 hectares of forest and land. However, the fires were only contained by 19.37%, making them the largest forest and land fires (KARHUTLA) in history. In the last five years, including 2019, the number of hotspots reached 5,263, potentially triggering forest and land fires (Putri et al., 2019). According to the Ministry of Environment and Forestry (KHLK), forest and land fires can occur every year in South Sumatra. Based on data from the Central Statistics Agency of South Sumatra Province, the most frequent natural disaster in 2023 was forest and land fires with 29 incidents throughout South Sumatra. In 2024, forest and land fires occurred covering an area of 2,948 hectares from January to June (MBKG, 2024). The high number of forest and

✉ Rika Anggraini rikagrni@gmail.com
Sugiarti sugiartialatiq@gmail.com
Sulistiawati sulistiawati@univpgri-palembang.ac.id

Physics Education Study Program, PGRI University Palembang, Indonesia.

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land fires in South Sumatra requires human awareness to always care for and maintain the health of nature. The factors that cause forest and land fires are caused by internal and external factors. If internal factors cannot be minimized, then external factors need to be developed to reduce the incidence of forest fires in South Sumatra.

External factors can be initiated by socializing the importance of environmental health and the negative impacts of environmental damage due to local community behavior (Pratama, 2022). Disaster mitigation education in schools can also be implemented as learning to prepare students to understand the impact of disasters and student preparedness if a disaster occurs in their residence (Putri et al., 2019; Zakwandi et al., 2018). According to (Wibowo & Syaifulloh, 2022)natural disaster mitigation learning can also shape students' behavior or attitudes in loving the environment and the surrounding nature, this learning can be started by linking it to learning. According to (Heinrich, 2022)mitigation or prevention in order to increase students' insight regarding disaster mitigation can be carried out through knowledge-based disaster socialization. Disaster mitigation education is implemented through three main approaches, namely class-based, school habits, and community involvement. One approach that can be implemented is class-based, by integrating mitigation education into physics subjects (Opilah et al., 2023).

Based on this explanation, it can be concluded that learning containing forest and land fire disaster mitigation needs to be implemented in the educational field as an effort to shape students' character, who love the environment and are prepared to face unexpected disasters. This integration of learning can be applied in the fields of Natural Sciences (IPA) and Social Sciences (IPS) and depends on the intensity and relevance of the material to disaster mitigation. According to (Sudrajad, 2022)in the aspect of natural sciences, physics is one of the subjects relevant to disaster mitigation. This is supported by the existence of several environmentally oriented physics materials such as temperature and heat, thermodynamics, waves, and so on.

Integrating disaster mitigation into subjects can be implemented in the form of modules or electronic modules that utilize. The use of e-modules in disaster mitigation learning is interesting to implement and effective in improving students' critical thinking skills (Yoga et al., 2021). This is confirmed by (Khusna et al., 2024)who argues that e-modules can increase students' awareness of environmental concerns and disaster preparedness.

Based on the results of an interview with one of the educators at SMPI 33 Al-Azhar in media aspects, methods learning, learning process, and facilities school, then obtained information that in the learning process at the school has not implemented learning materials related to environmental phenomena, including mitigation of forest and land fires. This can increase the lack of knowledge and awareness of students regarding natural disaster mitigation. Lack of knowledge about disasters can increase the risk of natural disasters (Rakuasa & Mehdila, 2023). In addition, the school has not used e-modules in the physics learning process, especially physics e-modules integrated with disasters. The learning process is only based on books and learning videos. However, the temperature and heat material in the books used at the school is not always available, so it can hinder student understanding, and the temperature and heat material contained in the books has not helped improve the character of love for the environment and preparedness for disasters, especially forest and land fires that often occur in the South Sumatra region. According to Arifuddin et al., (2023)that the application of e-module learning based on physics modeling and environmental phenomena can significantly improve

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problem-solving and analytical skills in the learning process. Problem-solving and analytical skills can be improved by using *problem-based learning methods.* (Hayati, 2023).

Based on the results of interviews and the frequent forest fire disasters in South Sumatra, integrated disaster mitigation teaching materials are needed to improve students' character, fostering a love for the environment and preparedness for unexpected disasters. This also enhances students' understanding of temperature and heat concepts and their ability to analyze temperature and heat material in relation to forest and land fire phenomena. This serves as the basis for researchers to develop an e-module on temperature and heat integrated with disaster mitigation. This development, according to (Ramadanti et al., 2021) Learning related to the environment gives rise to problems and can use problem *-based* learning methods. In developing the e-module, researchers used *Flipbook Heyzine* because this software has several advantages, including: *multiple views,* direct editing, can add animated videos, photos, easy to use, and innovative (Auwaliyah et al., 2023). So from the series of descriptions above, the title that will be developed in this study is: "Development of an Integrated Temperature and Heat E-module for Forest and Land Fire Disaster Mitigation to Improve the Analytical Skills of Grade VII Students".

METHOD

This research uses the *Research and Development* (R&D) method. This method is in line with the statement that development research aims to produce products in the field of education (Emzir, 2007). The main reference in this research is to develop valid, practical, and effective products for use in learning. So it can be concluded that development research is research with the aim of creating a product or improving an existing product. The development model used is ADDIE, which consists of five steps, namely: (1) *Analysis,* stage This started with observe phenomenon nature that often occurred in the South Sumatra region and connected it to the field education. (2) *Design* (planning), carrying out design related the solution obtained after do analysis. (3) Development, (3) *Implementation,* (4) Evaluation, in *the evaluation stage using Tessmer's* formative evaluation model, it consists of four stages, namely: (1) *self-evaluation,* (2) *expert review,* stage v of expert validation was conducted to review the e-module in terms of material, language, and media aspects before the field trial. Expert validation consisted of three experts, two of whom were lecturers at the PGRI Palembang University physics and science education study programs in the field of mitigation, and the third expert validation is a teacher at SMPI Al-Azhar 33 Palembang, (3) *one to one evaluation,* which is stages e- module assessment from three student before the learning process using e- modules implemented, (4) *small group evaluation,* stage This is a trial stage carried out on students and only involves 10% of the students amount all over student in One class. The *small group* trial phase was conducted after the implementation of the teaching and learning process using the developed e-module, with 10 % of students in class VII randomly selected. The data collection techniques in this study were as follows:

Observation and interviews

Observation is the initial step in identifying problems in the field. Observations were conducted at the school under study, noting frequent events in the local area. Following this, an

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interview with one of the educators was conducted to obtain information about the school's facilities, methods, and learning processes.

Questionnaire

A questionnaire is a data collection technique that is systematically structured in the form of questions. In this case, the questionnaire was used to assess the validity and practicality of the developed e-module in terms of media, materials, and language. The criteria are: in determining the level of validity of the e-module as follows:

Table 1 Criteria for the level of validity and practicality

Criteria	Score
Totally invalid	1.00 - 1.80
Invalid	1.81 - 2.60
Quite valid	2.61 - 3.40
Valid	3.41 - 4.20
Very valid	4.21 – 5.00

Source: (Agsaenanda, 2020)

Test

The test analysis stage is the stage to determine the level of student understanding before and after the research is conducted on students. Test analysis at this stage uses the N-gain test. The systematics of the N-gain test according to (Hake, 1999a)are as follows:

$$N - Gain = \frac{S_{post} - S_{pre}}{S_{maks} - S_{pre}} \quad (2)$$

where *N-gain* = increase in disaster preparedness capacity (N-Gain score); S_{pre} = pretest score; S_{post} = posttest score; and S_{max} = maximum score.

RESULTS AND DISCUSSION

This research uses the Research and Development (R&D) research method with the ADDIE development model which consists of five steps, namely: analysis, design (planning), Development (development), Implementation (implementation), Evaluation. The evaluation stage uses the Tessmer formative evaluation model, which consists of four stages: self-evaluation, which rechecks the integrated temperature and heat e-module for forest and land fire disaster mitigation that has been developed. If there are errors in the e-module, ranging from writing, design, or inappropriate material, it will be revised independently by the individual. Expert review, the validation stage is carried out by the validator, at this stage the assessment includes material aspects, media aspects, and language aspects used in e-module development. One to one evaluation is stage evaluation three student related developed products before carrying out the learning process teach. S mall group, stage group small 10% of amount student in class For evaluate developed products after the learning process teaching. Last is evaluation stage that is evaluate results from study.

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Analysis

Disaster analysis and teacher interviews

Based on data from the South Sumatra Provincial Statistics Agency (BPS) and the Regional Disaster Management Agency (BPBD), forest and land fires occur almost annually in South Sumatra. After analyzing the disasters, a needs analysis was conducted to improve school awareness of disaster mitigation through interviews with teachers at SMPI Al-Azhar 33 Palembang.

Content analysis

The content analysis phase aims to review the learning materials to be developed. Based on the phenomenon of forest fires and several studies, forest and land fires are related to physics concepts, namely temperature and heat. At this stage, researchers also reviewed the syllabus, learning objectives, and learning outcomes in Phase D for the temperature and heat material in the Independent Curriculum.

Media analysis

The media analysis stage involves analyzing the electronic presentation of the module to be developed. Researchers used *Heyzine Flipbooks* as a tool in developing the electronic module. *Heyzine Flipbooks* has the advantages of being easily accessible *online for both Android* and *iOS* users, is free, has image and video display features, and is easy to implement (Auwaliyah et al., 2023).

Structural analysis

Structural analysis aims to compile the scope of information that will be presented in the electronic module, the structure of the e-module which will be developed using the *Problem Based Learning method.*

Design

The design stage is the initial step in designing the product to be developed, namely an e-module on temperature and heat integrated with forest and land fire disaster mitigation. The initial step in designing the e-module begins with e-module components such as the e-module display concept, concept maps, materials, interesting learning images or videos, experiments or experiments for data presentation by students, and practice questions. In the aspect of temperature and heat material, references are used through school textbooks and several books from various sources as well as articles related to forest fire events and their mitigation.

Development

Media development

Based on the previous initial design, the initial step in developing an e-module begins with e-module components such as the e-module display concept, concept map, materials, case studies of forest and land fires, interesting learning images or videos, trials or experiments for presenting data by students, crossword puzzle games, and practice questions in the form of games. Components from the developed e - modules can seen in the section attachment.

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Table 3 Display of Teaching Materials

Teaching Material Display	
	
Initial look at the mitigation topic	A preliminary look at the Temperature topic
	
Crossword puzzle display on temperature and heat material	Display of temperature practice game.

Table 4. LKPD Display

Student Worksheet Display	
	
Initial display of LKPD on temperature material assisted by Phet	Display of the experimental procedure using Phet
	
Display of data presentation after conducting the Phet experiment.	Initial display of LKPD on heat material

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Self-evaluation

This stage is an evaluation carried out by oneself regarding the e-module that has been developed, this stage aims to correct deficiencies in the e-module such as errors in typing the material, inconsistent product appearance, and so on.

Expert validation

Expert validation was conducted to review the e-module's material, media, and language aspects prior to field trials. The validation aimed to determine the level of validity of the developed e-module. For the material aspect, the validator was given seven questions related to the e-module, five questions regarding the material aspect, and five questions regarding the language aspect. The results of the validator assessments can be seen in the graph below:

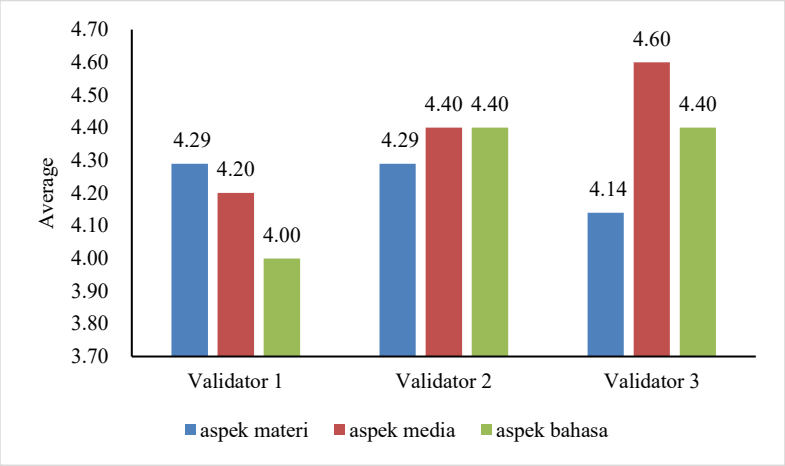

Figure 1 Average results of validator assessments

Based on the validator's assessment of the material, media, and language aspects, the overall average for the material aspect was 4.24, the media aspect was 4.40, and the language aspect was 4.30. The overall average results given by the validator determine the level of validity of the developed e-module and can be seen in the table below:

Table 5 Overall results of the average aspects of material, media, and language

No	Assessment Aspects	Average	Category
	Material Aspect	4.24	Very Valid
	Media Aspects	4.40	Very Valid
	Language Aspects	4.27	Very Valid
Amount		12.91	
Overall Average		**4.30**	
Category		**Very Valid**	

From the overall results, the average assessment of the material, media, and language aspects by the three validators related to the integrated temperature and heat e-module for forest and land fire disaster mitigation was 4.30. According to (Agsaenanda, 2020) if the overall average result is in the range of 4.21-5.00, it has very valid criteria. Therefore, it can be concluded that the e-module has the "Very Valid" criteria and can be tested with revisions according to the validator's comments and suggestions. The suggestions for improvement provided include: improving the front cover appearance, arranging media features to be more

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appropriate, consistency in image media captions, and improvements in writing the table of contents.

Implementation

The implementation phase is the trial phase of the revised e-module based on comments and suggestions from validators in the areas of subject matter, media, and language expertise. This phase was conducted on seventh-grade students, with only one class, VII.B, consisting of 22 students (10 boys and 12 girls). The study was conducted for one week. two hours of lessons, method learning using the *Problem Based Learning model,* at the meeting First student doing pre-test and meeting seventh at the end with do Post-test evaluation The field trial consisted of three stages: *one-to-one* and *small group,* which aimed to assess the level of validity and practicality of the e-module that had been developed and the final stage. evaluation For review improvement ability analysis student before-after learning process implemented using the developed e - module.

One to one stage

one-to-one phase is a trial phase conducted on students and only involves three people. The one-to-one trial phase was conducted before the implementation of the teaching and learning process using the developed e-module. Three students in grade VII were randomly selected. The results of the one-to-one trial in grade VII of SMPI Al-Azhar 33 Palembang are as follows:

Table 6. Percentage results of the one-to-one stage

No	Student Code	Score	Percentage (%)	Category
	MAF	41	82%	Practical
	APA	46	92%	Very Practical
	AJA	48	96%	Very Practical
Average percentage			90%	

one-to-one trial, the average (Agsaenanda, 2020) If the average percentage is in the range of 86%-100%, it is considered very practical. Therefore, it can be concluded that the e-module meets the "Very Practical" criteria.

Small group stage

small group stage is a trial stage carried out on students and only involves 10% of the class. amount student in class, because amount There are 22 students in class VII B of Al-Azhar Middle School so Small group testing was conducted on 10 students. The *small group* trial was conducted after the implementation of the teaching and learning process using the developed e-module. The selection of 10 students in grade VII was done randomly. The results of the *small group trial* in grade VII of SMPI Al-Azhar 33 Palembang are as follows:

Table 7. Results of the small group stage

No	Score	Presentation	Category
1.	47	94%	Practical
2.	47	94%	Very Practical
3.	38	76%	Very Practical
4.	35	70%	Quite Practical

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No	Score	Presentation	Category
5.	50	100%	Very Practical
6.	37	74%	Quite Practical
7.	47	94%	Very Practical
8.	39	78%	Practical
9.	46	92%	Very Practical
10.	41	82%	Practical
Total	427	85.4%	Practical

Table 8. Overall results of the practicum

No.	Assessment Aspects	Percentage	Category
1.	*One to one* stage	90%	Very Practical
2.	*Small group* stage	85.4%	Very Practical
Amount		175%	
Presentation		88%	
Category		Very Practical	

one-to-one and *small group* trials, the average percentage of student responses to the integrated temperature and heat e-module for forest and land fire disaster mitigation was 88%. According to (Agsaenanda, 2020)if the average percentage is in the range of 86%-100%, it is considered very practical. Therefore, it can be concluded that the e-module meets the "Very Practical" criteria.

Evaluation

N-gain test

The evaluation phase aims to assess the potential impact of the e-module on students' analytical skills after the field trial. This phase involves providing analytical questions related to temperature and heat integrated with forest and land fire mitigation. The analysis questions are divided into two phases: a pre-test before the e-module is implemented, and a post-test after the teaching and learning process has been completed. This evaluation phase was piloted on 22 seventh-grade students at SMPI Al-Azhar 33 Palembang. The N-gain test scores for the pre-test and post-test phases can be seen in the following graph:

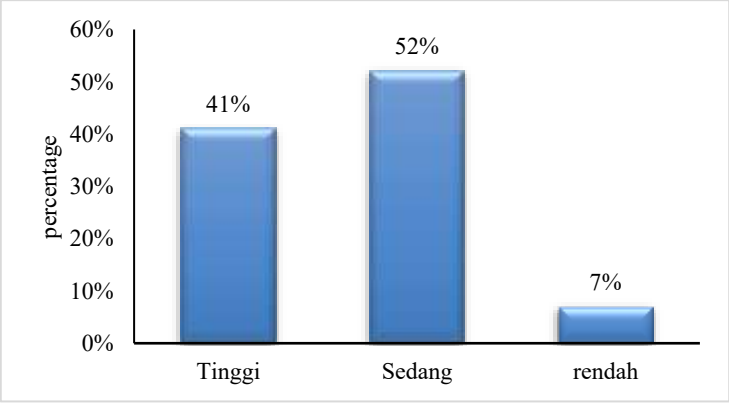

Figure 2. N-gain percentage graph by category

From the results of the N-gain test, the percentage of student scores related to the integrated temperature and heat e-module for forest and land fire disaster mitigation is divided into three aspects, namely, the high N-gain value category of 41%, the medium N-gain value category of 52%, and the low N-gain category of 7%. Through the results of the overall N-gain test value, the N-gain value is 59.17%. According to (Hake, 1999b)if the N-gain percentage is in the range of 56%-75% it has the criteria of '"Quite Effective". So, it can be concluded that the e-module has the criteria of "Quite Effective".

Evaluation of students' analytical skills

This evaluation aims to measure student understanding after a trial of the temperature and heat e-module integrated with forest and land fire mitigation. To determine student understanding of the material, students were given pre-test and post-test questions. In accordance with Bloom's taxonomy, the questions cover the aspects of understanding (C2), application (C3), and analysis (C4). The interpretation of student abilities after the trial of the temperature and heat e-module at the understanding stage is as follows:

Table 9. analysis of students' abilities at the understanding stage (C2)

Cognitive Level	Question Indicator	Average Score		Diff-erence	Interpretation
		pretest	post-test		
C2	Given a case study of the forest fire phenomenon in South Sumatra, students explain the temperature change factor in this case and then provide their rationale.	52	65	13	Students are able to explain the factors of temperature change well.
C2	Given a case study on the process of extinguishing forest fires, students summarize the function of foam in extinguishing forest fires and then provide their rationale.	36	60	24	Students can conclude the function of using foam to extinguish forest fires quite well.
C2	Given a case study of a forest fire, students will conclude how temperature affects the spread of fire and then explain their reasons.	39	91	52	Students can conclude the effect of temperature on forest and land fires correctly.
C2	Given a case study on forest fires, students understand the importance of maintaining forest health and then explain their reasons for doing so.	32	78	46	Students are able to understand the importance of properly maintaining forest health.
C2	A case study on forest fires is presented. Students provide examples of forest and land fire mitigation and then justify their responses.	39	100	61	Students are able to provide examples of forest and land fire mitigation appropriately.
C2	Presented with the phenomenon of heat transfer in everyday life, students interpret this phenomenon in terms of heat transfer events, then provide reasons.	43	95	52	Students are able to understand the concept of heat transfer in everyday life correctly.
Total		241	489		
Average		40.17	81.50		

The pretest and posttest results for the comprehension aspect (C2) showed an increase in students' understanding of the concepts of temperature and heat, from 40.17 in the pretest to

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80.50 in the posttest. This improvement was reflected in the students' ability to accurately explain, understand, provide examples, and summarize the concepts of temperature and heat integrated with forest and land fire mitigation.

Table 10. analysis of student abilities at the application stage (C3)

Cognitive Level	Question Indicator	Average Score		Difference	Interpretation
		pretest	post-test		
C3	The use of temperature scales in several countries is presented. Students calculate temperature scale conversions and then provide reasons for their use.	30	60	30	Students are able to calculate temperature conversions correctly.
C3	Students calculate the heat received by an object, then give reasons.	32	65	33	Students are able to calculate the heat received by an object correctly.
C3	A case study of a forest fire is presented. Students calculate the heat gained from the combustion and then explain their reasoning.	25	60	35	Students are able to calculate the heat produced by a fire quite correctly.
C3	A case study of a forest fire is presented. Students calculate the total energy of the fire and then provide reasons for their calculations.	27	60	33	Students are able to calculate the total energy produced by forest and land fires quite correctly.
Total		114	245		
Average		28.5	61.25		

The pretest and posttest results for the application aspect (C3) showed an increase in students' application of the concepts of temperature and heat, from 28.5 in the pretest to 61.25 in the posttest. This improvement was reflected in the students' ability to correctly calculate the concepts of temperature and heat integrated with forest and land fire mitigation.

Table 11. Analysis of students' abilities at the analysis stage (C4)

Cognitive Level	Question Indicator	Average Score		Difference	Interpretation
		pretest	post-test		
C4	A table of specific heat and a simple experiment are presented. Students analyze the materials being tested and then provide reasons for their findings.	9	68	59	Students are able to analyze the specific heat of an object correctly.
C4	A heat change diagram is presented. Students analyze the diagram that includes a change of state that releases heat, then provide reasons.	30	81	51	Students are able to analyze changes in the state of objects that release heat correctly.
C4	Two problems related to specific heat are presented. Students compare the two problems in terms of heat phenomena and then provide reasons for their responses.	27	70	43	Students are able to analyze the specific heat of objects correctly.
C4	A table of specific heats and a case study on heat are presented. Students analyze the specific heat of an object from the table and then provide reasons for their analysis.	18	60	42	Students are able to analyze the specific heat of objects quite correctly.

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Cognitive Level	Question Indicator	Average Score		Diff-erence	Interpretation
		pretest	post-test		
C4	Everyday life phenomena related to heat are presented. Students analyze the causes of these heat phenomena and then provide reasons for their occurrence.	16	60	44	Students are able to analyze heat events in everyday life quite correctly.
Total		100	339		
Average		20.00	67.8		

The results of the pretest and posttest on the analysis aspect (C4) showed an increase in students' analysis of the concepts of temperature and heat, from 20.00 in the pretest to 67.8 in the posttest. This increase is reflected in students' ability to analyze the concepts of temperature and heat in phenomena. forest and land fires capable analyze it with Good.

Based on the evaluation results, students' analytical skills are at level C2 according to Bloom's Taxonomy, which reflects their understanding. From the average pretest and posttest scores, it is clear that students are able to understand the concept of temperature, scale conversion, and its relationship to forest and land fires. This shows an increase in students' pretest and posttest results from 40.17 to 81.50 in the understanding aspect (C2). For level C3, which focuses on problem-solving skills, students are able to perform calculations related to temperature and heat and understand their relationship to forest and land fires. This is evidenced by an increase in the average pretest and posttest scores from 28.5 to 61.25. Meanwhile, at level C4 in Bloom's Taxonomy, which is related to analytical skills, students are able to analyze temperature, heat, and heat transfer and relate them to forest and land fires, this is shown by the average pretest and posttest scores from 20.00 to 67.8. This improvement in analytical skills aligns with research (Anwar Muhaimin, 2019)who argued that students' analytical skills can be said to improve if they are able to connect, group, and differentiate a problem. Meanwhile, according to (Hurulean et al., 2022)students are said to be able to analyze if they are able to identify the parts of a problem, solve them, and understand the relationships between the parts. Therefore, it can be concluded that the integrated temperature and heat e-module for forest and land fire mitigation can improve students' analytical skills.

In addition, through the results of the validator test on the developed e-module, the integrated temperature and heat e-module for forest and land fire mitigation has a validity level in the "Very Valid" category with an average of 4.30. This shows that the e-module is suitable for use in the learning process with the preparation of structured temperature and heat materials equipped with forest & land fire disaster mitigation learning, the media contained in the e-module is interesting, the presentation presented is easy to understand, the use of language contained in the e-module is in accordance with EYD, and can meet curriculum demands. This level of validity is in accordance with (Karunia, 2016)which revealed that the development of teaching materials integrated in disasters can increase understanding of disaster preparedness and is interesting and easy to apply, the use of e-modules can also train students' independence in learning (Kristina et al., 2022).

In the results of the practicality test of the developed e-module, the integrated temperature and heat e-module for forest and land fire disaster mitigation has a practicality level in the “Very Practical" category with a percentage of 88% and shows that the e-module is very easy to apply,

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the material presented is structured and easy to understand, the visual appearance of the e-module is attractive and not boring, learning can be used anytime and anywhere, and the use of sentences in the e-module is easy to understand. This has continuity in (Kristina et al., 2022)which states that the use of e-modules is practical and effective for use in junior high school students and can be integrated into the environment, so that students not only understand the scientific aspects but can form the character of students who care about the environment (Salsabila, 2021).

Based on the results of the N-gain test, the effectiveness level of the e-module in improving students' analytical skills is categorized as "Quite Effective" with an N-gain test value of 0.59. This is supported by the availability of animated learning videos in the e-module, helping students more actively analyze the phenomenon of forest and land fires and examine them in the material of temperature and heat. In addition, game-based exercises and example questions in the interactive e-module also increase their enthusiasm for learning. The level of effectiveness of the developed e-module is in line with research by (Mutmainnah et al., 2021)which states that the use of e-modules is effective in improving students' cognitive abilities and is very practical to apply in the learning process. E-module-based teaching media can also facilitate more dynamic interactions between students and learning materials. With interactive features, practice questions, and visual animations, e-modules not only improve conceptual understanding but also encourage active involvement in learning. Furthermore, their accessibility allows students to learn anytime and anywhere according to their needs (Sumarni Sahjat et al., 2023).

CONCLUSION

The developed integrated temperature and heat e-module for forest and land fire mitigation has proven to be highly valid, with an average expert assessment of 4.30. This module is also considered practical, supported by the results of *one-to-one questionnaires* with a percentage of 90% and small group 85.4%, with a total overall percentage of 88%. In addition, the developed e-module is also considered effective in improving students' analytical skills, with the results of the N-gain test based on categories of 40.71% of students in the high category, 51.84% in the medium category, and 7.45% in the low category. Based on the N-gain test stage, the level of effectiveness of the e-module is quite high with a score of 59.17% (the "Quite Effective" category according to Hake, 1999). With proven validity, ease of use, and effectiveness, this e-module is a learning innovation that supports students' understanding of temperature, heat, and forest and land fire mitigation. An e-module of temperature and heat integrated with forest and land fire mitigation has been developed to improve students' analytical skills. This is indicated by the increase in the average pre-test and post-test scores of each student at the cognitive level according to Bloom's taxonomy (W. Anderson, 2010)with C2 (understanding), C3 (Applying), and C4 (Analyzing). For further researchers, the developed e-module can be refined by reviewing disaster mitigation according to natural disasters that often occur in the local area.

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