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Development of an E-module on the Material of Substance Pressure and Its Use in Daily Life, Based on Science Process Skills

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ABSTRACT: The science learning process is anticipated to be able to offer an independent learning experience by utilizing previously acquired skills, namely science process skills. Based on the needs analysis, students get bored easily, are lazy, and find it difficult to accept science learning. In addition, worksheets and printed books that are used as learning resources have not implemented current technological developments, as a result students are bored and less interested. Teachers as science learning practitioners still find it difficult to provide learning media that have the capacity to pique students' interest. So, this research was conducted to develop an e-module centered on scientific process skills in the area of substance stress and its practical application, as well as evaluating its efficacy. The methodology employed in the research was the ADDIE R&D model which was carried out in class IX at SMP Nasional Malang. Data collection was done through student analysis questionnaires, media validity questionnaires, material validity questionnaires, student readability test questionnaires, and practicality test questionnaires by science teachers. Overall, the validity of the material is 92%, the validity of the media is 97.2%, the readability of students is 86.61%, and the practicality of science teachers is 99%. Therefore, this e-module is very feasible and effective to be applied to the science learning process in junior high schools on substance stress and its application in daily life.

Keywords: e-module, science process skills, material of substance pressure

INTRODUCTION

Advances in science in the technological era have resulted in the use of information sophistication to become an important part of learning activities [1, 2]. The existence of technology can also broaden the learning experience of both teachers and students, because technology can be used in learning outside the classroom and at any time in order for pupils to become more self-reliant during the learning process [3]. Learning through modules can provide opportunities for students to further explore their abilities so as to create independent or student-centered learning [4]. Distance learning has been made possible by the advancement of information technology, which can now process, package, display, and distribute learning materials that are visual, audio-visual, and even multimedia [5, 6]. This concept then develops so that learning can be arranged more attractively for students wherever they are [7, 8]. Images, audio, video, animation, and the like can be added to the e-module to make the layout and appearance more attractive to students to use it [9, 10].

A module is a teaching material that is designed in a coherent and structured manner using language that is more understandable to students according to their level and age, thus enabling them to learn both with the help of a teacher and independently [11, 12]. Whereas worksheets are used to stimulate learning or teacher guides are given in writing, so attention must be paid to the visual aspect to attract students' interest [13, 14]. From these differences, the use of e-modules stimulates students to learn independently both in finding concepts and material.

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Not only that, the implementation of science learning in Indonesia is not free from problems that can hinder the success of learning objectives [15, 16]. The issue that still has to be resolved is the poor level of science process abilities that junior high school pupils possess when learning science [17, 18]. Meanwhile, in facing the challenges of the 21st century, the skills that must be applied in the educational process are higher-order thinking skills which include science process skills [19, 20]. In line with research at the international level by the OECD on the Program for International Student Assessment (PISA) it also demonstrates that students' science process skills are still low [21]. What's more, science subjects in the 2013 curriculum are designed as integrative science-based learning that is focused on learning abilities, thinking skills, application orientation and high curiosity [22]. With the 2013 curriculum learning concept, science learning designs should be implemented to trigger students' active learning skills in constructing the knowledge they already have. So that students easily remember the material presented and not easily forgotten.

All scientific abilities that are used to obtain ideas, theories, or principles, develop already-existing conceptions, or dispute earlier observations are referred to as science process skills [23]. Observing, communicating, classifying, measuring, drawing conclusions, forecasting, identifying variables, identifying tables, identifying graphs, defining the connections between variables, collecting and processing information, evaluating research, formulating theories, and carrying out experiments are some of the indicators that make up science process skills [24, 25]. The integration of science process skills with mental, intellectual, physical, and social skills helps foster the development of cognitive abilities in students, enabling them to acquire practical knowledge, skills, and attitudes [26].

Science material that has the potential to increase the competency of science process skills is material stress and its application in daily life because there are still many students who experience misunderstandings [27]. Substance pressure material is abstract material so visualization is needed in order to facilitate learning for students to see phenomena related to daily life [28]. One of these visualizations can be applied by conducting experiments in the learning process [29, 30]. In order to be able to practice science process skills, discovery learning models are also used because they can involve students to gain experience actively by carrying out a series of discovery activities [31].

The outcomes of the requirements analysis that was completed in class IX at SMP Nasional Malang, a total of 23 students, stated that 81.74% of students were interested in digital-based learning resources because they can be read and studied anywhere and anytime, so it is effective for adding references to learning science, especially materials the pressure of substances and their application in daily life because they are difficult to understand. 79.13% of students also feel bored and less interested if the learning resources used only display material in printed books without being accompanied by features that can attract students to deepen the material. In addition, 70.43% of students are less motivated to learn if they are still focused on the teacher explaining the material. That is, students will be encouraged to learn independently when supported by well-designed learning resources in building the skills they have mastered, among these are science process skills.

Then, the questionnaire given to science teachers as learning practitioners stated that teachers were still having difficulty finding media that stimulated students' interest and zeal for studying science. The use of learning resources is still focused on printed books, PPT, and videos which are less effective in supporting students' understanding and learning outcomes. During science learning, the development of electronic learning resources (e-modules) has never been carried out, especially based on science process skills that are effective and efficient and equipped with features that can attract students. The teacher also stated that students were often sleepy and lazy when learning took place so that the knowledge obtained was less than optimal.

From the needs analysis and description of the facts above, it is necessary to develop e-modules that are designed as attractive and detailed as possible in order to provide solutions for students in discovering concepts, knowledge, and practicing science process skills. The development of this e-module is also pursued as the utilization of digital media in order to keep abreast of the times. So that students can be moved by their enthusiasm in learning in class and also wherever these students are located with the presence or absence of teacher guidance because of its practical use. Through the help of anyflip which is designed to assist teachers in compiling e-books both with desktop and mobile, teachers can be assisted in delivering interesting learning material despite limited space and time. The need for learning using anyflip is due to the need for learning to understand material that is still abstract for students [32].

RESEARCH METHODS

This study utilizes the five-stage ADDIE (Analysis, Design, Development, Implementation, and Evaluation) model for Research and Development (R&D), which is a systematic approach designed to ensure comprehensive development of the e-module based on science process skills in the context of substance pressure and its applications in daily life. The ADDIE model consists of interconnected phases that guide the entire research process from initial needs analysis to final evaluation, as outlined in Figure 1 [33]. Each phase contributes to the effectiveness and validity of the developed product.

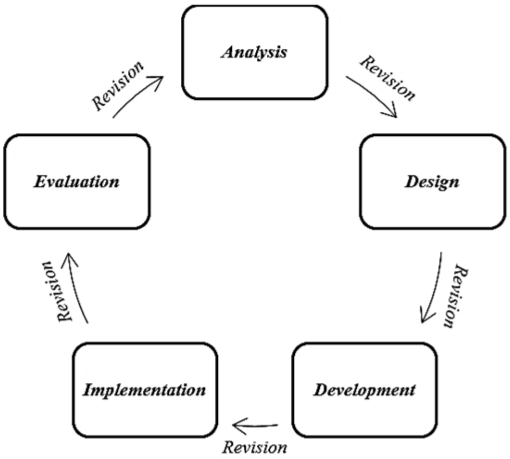

FIGURE 1. The ADDIE model

Research Design

The research follows a mixed-method design incorporating both qualitative and quantitative data collection methods. This approach enables a robust analysis of the e-module's development, testing, and evaluation. The quantitative aspect primarily evaluates the effectiveness and validity of the e-module through questionnaires and tests, while qualitative feedback is collected through expert reviews and practitioner comments.

Research Response

The study focuses on gathering responses from both students and science teachers, who are the primary respondents in this study. The responses are used to assess the validity, readability, and practicality of the e-module, as well as its effectiveness in enhancing science process skills.

Research Location

The research was conducted at SMP Nasional Malang, where class IX students participated in the study. A total of 23 students were involved in the development and evaluation phases, while 21 students from class VIII participated in pre-test and post-test assessments.

Research Instruments

The instruments used for data collection include:

1. **Questionnaires**: Google Forms were used to collect responses from students, science teachers, and expert validators. The questionnaires focused on assessing the validity of the media, material, readability, and practicality of the e-module.
2. **Tests**: Pre-tests and post-tests were administered to evaluate students' cognitive understanding before and after the use of the e-module.
3. **Expert Validation**: Material and media experts, as well as science teachers, provided feedback through structured validation forms to assess the quality and effectiveness of the e-module.

Data Collection Procedures

Data was collected in the following manner:

1. A needs analysis was first conducted through questionnaires distributed to students and science teachers.
2. The design of the e-module was based on the analysis, followed by the development of the product.
3. Validation of the e-module was performed by expert reviewers, including a science education department lecturer and a physics education department lecturer.
4. The developed e-module was then tested for usability by the target group (class IX students), followed by the administration of pre- and post-tests to evaluate its impact on learning outcomes.

Data Processing

The collected data was processed using both qualitative and quantitative techniques:

1. Qualitative Data: Feedback from expert reviewers and practitioners was analyzed thematically to identify areas for improvement in the e-module design and content.
2. Quantitative Data: Likert-scale responses from the questionnaires were analyzed using statistical software. The pre-test and post-test results were compared using paired t-tests to assess the impact of the e-module on students' learning outcomes. Additionally, the N-gain score was calculated to measure the effectiveness of the e-module.

In the first stage of analysis a needs analysis was carried out in class IX with a total of 23 students at SMP Nasional Malang by giving questionnaires via Google forms and giving written questionnaires to science teachers as learning practitioners. This stage is carried out as a reference in product development in the form of e-modules. The second stage of design is designing and planning by systematically designing the product as well as the contents in it to facilitate the product development process. In the third stage of development, product development is carried out according to a pre-designed design, finished products are immediately published via anyflip media. Then compile material expert validity instruments, media expert validity, student readability questionnaires, and science teacher practicality questionnaires. To test the validity of the product, the researcher tested the expert validator by a science education department lecturer. Furthermore, for the validity of the material to the expert validator by the physics education department lecturer. After that, revisions were made to the comments and corrective responses given by the validator lecturer. The fourth stage is implementation or application of the e-module that has been developed for legibility by class IX students with a total of 23 students who have received material on substance stress and its application in daily life. In addition, it is practical for science teachers as learning practitioners. Before being implemented, a pre-test was given to measure cognitive initial understanding in class VIII with a total of 21 students, followed by the application of learning using the e-module which was developed with the assistance of the teacher and also researchers according to the instructions contained in the e-module. After completing the use of the e-module, a post-test is given to determine the effect of developing the developed e-module. The final stage is product evaluation by revising based on the data obtained so that it is suitable for use in learning Natural Sciences material on substance stress and its application in daily life.

The research data generated is qualitative and quantitative data, in which qualitative data is obtained from corrective comments and input obtained from expert validators, namely lecturers from the science education department, physics education department lecturers, and science teachers as practitioners in the learning process. Meanwhile, quantitative data was obtained through a questionnaire provided via Google Forms with an assessment of the Likert scale, Guttman scale, and the test.

For media validity, material validity, product readability, and practicality, scoring was used using a Likert scale from 1 to 5. With information on a scale of 1 = very poor, scale 2 = not enough, scale 3 = sufficient, scale 4 = good, and scale 5 = very good [34].

Whereas in testing the correctness of the concept, the pre-test and post-test use the Guttman scale for a more firm answer related to a research statement so that a scale of 0 = wrong and 1 = right is used [35].

Furthermore, to calculate the percentage of data obtained by the equation: $V = Tse/Tsh \times 100\%$ with the validity score according to Table 1 [36].

Information:

- V : validation
- Tse : total value obtained
- Tsh : total maximum value

TABLE 1. Product Validity Scoring Criteria

Score	Criteria
81.00%-100.00%	Very Valid (no need for revision)
61.00%-80.00%	Sufficient (revised as necessary)
41.00%-60.00%	Invalid (quite a lot of revisions)
21.00%-40.00%	Invalid (cannot be used)
00.00%-20.00%	Very Invalid (cannot be used)

The obtained data was then subjected to a normality test to ascertain whether or not its distribution was normally distributed. According to the following premise, the Shapiro-Wilk test is the type of normality test that is used for two related samples, specifically between pre-test and post-test values with a significance level of 0.05:

- H_0 : there is an irregular distribution of the data
- H_a : The distribution of data is normal

According to this hypothesis, data is considered regularly distributed when the significance value (Sig.) > 0.05; on the other hand, data obtained is not normally distributed when the significance value (Sig.) < 0.05 [37].

In addition, the t-test, a paired samples test with a significance threshold of 5% based on the following hypothesis, is utilized to ascertain whether the pre-test and post-test results of the e-module being created differ significantly:

- H_0 : the created e-module's pre-test and post-test values do not significantly differ from one another
- H_a : the generated e-module's pre-test and post-test values differ significantly from one another

This hypothesis states that Ha is accepted and H0 is rejected if the significance value of Sig. (2-tailed) < 0.05, showing a significant difference between the pre-test and post-test values of the e-module under development. On the other hand, Ha is refused and H0 is permitted if the significance value of Sig. (2-tailed) > 0.05 shows that there is no significant difference between the pre-test and post-test values of the e-module under development.

Next, you can use the n-gain score test to determine the efficacy of the product by comparing the results of the pre- and post-tests taken before and after receiving the e-module [38]. The criteria for the results obtained can be adjusted according to Table 2.

Formula:

$$G = \frac{Xposttest - Xpretest}{Xideal - Xpretest}$$

Information:

- G *: gain score*
- $X_{pre-test}$ *: score pre-test*
- $X_{post-test}$ *: score post-test*
- X_{ideal} *: score maximum*

TABLE 2. Criteria for N-Gain Score

Score	Description	Criteria
100	Very effective	High
0.70 <g ≥ 0.30	Effective	Medium
g < 0.30	Not effective	Low

The implementation of several indicators of science process skills includes aspects that are customized to meet the needs of pupils and those that allow it to be carried out include: observing, conducting experiments, formulating hypotheses, concluding, and communicating. This is evident from Table 3.

TABLE 3. Indicators of Science Process Skills

Indicator	Description
Observing	There is an aspect of "LET'S OBSERVATION"
Formulating a Hypothesis	There is an aspect of "GROUP DISCUSSION"
Conducting Experiments	There are aspects of "ACTIVITY 1, ACTIVITY 2, and ACTIVITY 3"
Concluding	There is an aspect of "Conclusion in Experimental Activities"
Communicating	There is an aspect of "LET'S COMMUNICATE"

RESULT AND DISCUSSION

This research produced an e-module based on science process skills on the subject matter of substance stress and its application in daily life. The product developed can make it easier for students to practice their science process skills with the features provided in the e-module. The features provided include: study guides, games, videos, indicators of science process skills, scientist information, and several questions packaged using QR Code technology. All of these features are packaged into one pdf file and then converted into anyflip which can be accessed effectively anywhere and anytime. The developed e-module also aims to trigger students' enthusiasm for learning independently even without being accompanied by a teacher in class. The drawback, though, is that you won't be able to use it effectively if you don't have an internet connection. To minimize this, a pdf file can be provided which can be accessed even without the internet, but some features still require a connected internet.

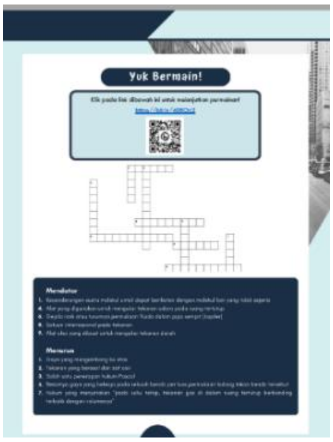

FIGURE 2. An Example of a Feature in an E-module

Link E-modul: https://anyflip.com/zgiom/amyl/

After product development, material validity calculations are carried out to produce data according to Table 4.

TABLE 4. Material Validity Results

No	Indicator	Score	Category
1.	Aspect of Language Feasibility	86,67%	Very Valid
2.	Content Eligibility Aspect	96,67%	Very Valid
3.	Conformance Aspect with Science Skills Indicator	92%	Very Valid
Average		92%	Very Valid

From the Table 4, the language feasibility aspect yields 86.67%, the content feasibility aspect yields 96.67%, and the suitability aspect with the indicators of science skills earns 92%, with an overall average acquisition of 92%. This shows that the developed e-module is included in the very valid category.

TABLE 5. Results of the Validity of Concept Truth, Pre-test, and Post-test

No	Indicator	Score	Category
1.	Concept	100%	Very valid
2.	Pre-test and Post-test	100%	Very valid

Table 5 is a table of the results of the validity of the concept which yields 100%, and the pre-test and post-test scores yield 100%. This shows a very valid category.

TABLE 6. Media Validity Results

No	Indicator	Score	Category
1.	Aspects of Size	100%	Very valid
2.	Graphic Aspects and Content	94,4%	Very valid
Average		97,2%	Very valid

Table 6 shows the results of the validity of the media from the size aspect yielding 100% and the graphic and content aspects yielding 94.4%, so that the overall average obtained was 97.2% which is included in the very valid category.

TABLE 7. Practicality and Readability Validity Results

No	Indicator	Score	Category
1.	Teacher Practicality	99%	Very valid
2.	Readability of Learners	86,61%	Very valid

Furthermore, for table 7 the results of the practicality validity of the science teacher as a learning practitioner obtained 99% included in the very valid and legible category of students in class IX at SMP Nasional Malang, a total of 23 students who had received material on substance stress and its application in daily life obtained a result of 86, 61% which is very valid. So that the product developed is very feasible to be applied in learning.

Subsequently, a Sig value of 0.660 was obtained post-test and a Sig value of 0.641 was acquired pre-test for the Shapiro-Wilk normality test. This demonstrates that the value is greater than 0.05, indicating a normal distribution of the data. The significant difference between the pre-test and post-test values of the e-module under development was then ascertained using a t-test. Because it compares two related samples, the paired samples test type of t-test is employed. At a significance threshold of 5%, it yields Sig. (2-tailed) $P < 0.05$, indicating a significant difference between the pre- and post-test values of the e-module under construction, which results in the acceptance of Ha and the rejection of H0.

The constructed e-module is tested for efficacy in the final step, and the result is a value of 0.57, falling into the category of moderate and effective. Because it improves students' cognitive abilities, the science process skills-based e-module on substance stress and its application in daily life can be deemed successful for use in the classroom.

CONCLUSION

It can be concluded that this research produced a development product in the shape of an e-module based on science process skills on the subject matter of substance stress and its application in daily life which to test the effectiveness of students' cognitive outcomes resulted in a moderate level of 0.57. This means that this e-module is effective to be applied to science learning subject matter pressure and its application in daily life. Based on the overall results obtained, it obtained 92% validity of the material, 97.2% validity of the media, 86.61% readability of students, and 99% practicality of science teachers. In addition, this research can further develop the skills possessed, especially in students' science process skills. Suggestions for future researchers are to further optimize the application of e-modules that are developed with a massive distribution so that they are useful and can be known by more students. In addition, before distributing the pre-test and post-test it should be tested for reliability first so that it is more valid to be given to students. Then for future teachers to develop more learning media that can increase the enthusiasm of students in learning science.

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