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Analysis of Validity and Learner Response to the Development of Pro-Environment Based Teaching Materials on Global Warming Material

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Abstract

Pro-environmental attitudes are specific actions a person takes to minimize the negative impacts of human activities on the environment and environmental health. This research aims to determine the validity and response of senior high school students to environment-based teaching materials. This study is classified as research and development (R&D), and the ADDIE model, which stands for analysis, design, development, implementation, and evaluation, is the paradigm used. Two media validators and two material validators verified the teaching materials. The validation results from material aspects obtained a percentage of 1.6% and media aspects a percentage of 6%, both of which are included in the valid category. Students' response results to teaching materials are in the very practical categories, with a mean percentage of 85%. Based on the results of validity and student responses, it can be concluded that the pro-environment-based teaching materials on global warming developed are valid and can be used in the physics learning process in high schools to increase students' knowledge and character towards the environment.

Keywords: global warming; pro-environment; validity

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INTRODUCTION

Global warming is a worldwide problem because it is not only experienced by the Indonesian population, but almost the entire world also feels it. Global warming is the process of absorbing heat from the sun through the Earth's atmosphere and emitting it back into space in the form of infrared radiation. However, not all of this radiation can penetrate the Earth's atmosphere, so greenhouse gases trap some of it in the Earth's atmosphere. The trapping of infrared radiation in the Earth's atmosphere causes the Earth to become hotter and is a significant concern for the world's future (Haryanti, 2022; Keniah, 2023; Margareth et al., 2023).

Indonesia is already experiencing global warming quite rapidly. This phenomenon stems from lifestyles and activities that damage the environment and are carried out by humans, which can lead to detrimental climate change (Ainurrohmah & Sudarti, 2022; Bian, 2020; Forster et al., 2023). It is one of the factors carried out by humans, both directly and indirectly, that can impact our Earth; for example, environmental

damage, illegal logging, poaching, destruction of mangrove forests, filling in swamp forests for settlements, dumping garbage in any place, development in watersheds, and so on (Rukiah, 2019). Another cause that can cause environmental damage is a lack of awareness about how to dispose of waste in its proper place. In the context of Indonesian society, there is still no awareness of how to protect, preserve, and care for the environment (Purwaningrum, 2016).

Efforts to overcome the problem of global warming can be made through a person's understanding of pro-environmental behaviour. Pro-environmental behavior is a conscious action taken by a person to minimize the impact of negative human activities on the environment and promote environmental health (Uesugi & Kudo, 2020; Widhiastuti et al., 2020). High pro-environmental behaviour is significant for individuals because it has positive impacts, such as reduced energy consumption and air pollution, which can improve human and environmental health and reduce costs associated with energy consumption (Ahmad, 2019; Ogunkunbi & Meszaros, 2023; Rezaei-Moghaddam et al., 2020). Pro-environmental behaviour is fundamental among adolescents, as they are the future assets of the nation that determine sustainable environmental policies (Ha & Kwon, 2016; Pratiwi, 2020). At the student level, pro-environmental behaviour is essential, especially by students, as one of the components of society that can be an example of environmentally friendly behaviour (Karpudewan et al., 2015; Sigit et al., 2020).

The results of research conducted in Central Jakarta on residents aged 20–40 years with middle socio-economic status revealed that the majority of respondents (51.6%) have low levels of pro-environmental behaviour caused by a less supportive physical environment (Arlinkasari et al., 2017). Research related to pro-environmental behaviour has been conducted on students majoring in accounting at universities in Semarang City, showing that the average respondent is less active in environmental conservation efforts, which indicates that the student has a low level of pro-environmental behaviour (Hernawati & Saputro, 2020). These results suggest a need for teaching materials that can help increase understanding of pro-environmental behaviour.

Teaching materials are an essential part of the learning process and can be utilized for learning purposes (Erniyanti et al., 2020; Magdalena et al., 2020; Putri & Aznam, 2019). Based on observations of various references to SMA/MA physics books relating to the material of global warming, the researchers found that global warming material in SMA/MA physics books tends only to contain a very brief summary. The results of this observation show that there is still a lack of teaching materials for high school physics that emphasize the urgency of global warming that is being experienced today, so teaching materials for high school physics on global warming still need to be developed. The development of teaching material is required to increase ability (theoretical, conceptual, moral, and technical) through education and training. It has made a massive contribution to the success of teaching and learning in the classroom (Deressa et al., 2022; Khoiri & Peterianus, 2021).

Based on this, teaching materials that can influence awareness to protect the environment are needed. Therefore, pro-environment-based teaching materials on global warming for high school students were developed. The developed teaching materials are expected to make students consider the good and bad of their behaviour by linking the impact that may

occur afterwards. In instilling this behaviour, students are given knowledge about the issue of global warming, especially in environmental education, to bring up wise behaviour in acting because they are aware that the environment can be disturbed by its ecosystem and other things that result in the heat of the Earth's temperature if they carry out activities that are not pro-environment. This researcher is developing pro-environmental-based teaching materials on global warming with the hope that they can contribute to advancing education and environmental health (Haryanti, 2022).

METHOD

This development refers to R&D (research and development) research proposed by Borg & Gall (1989). The product to be developed and tested for validity is teaching materials with the theme of global warming, defining research development as systematic studies about the design, development, and evaluate learning programmes, processes, and products that should fulfil the criteria of validity and practicability. The ADDIE model proposed by Reiser and Mollanda (1967) is the research model used. The development model comprises five stages: analysis, design, development, implementation, and evaluation.

The data acquisition technique in this research is a questionnaire to determine the validity of teaching materials developed on pro-environmental-based global warming material, in developing teaching materials, questionnaires for learners and material and media experts were used.

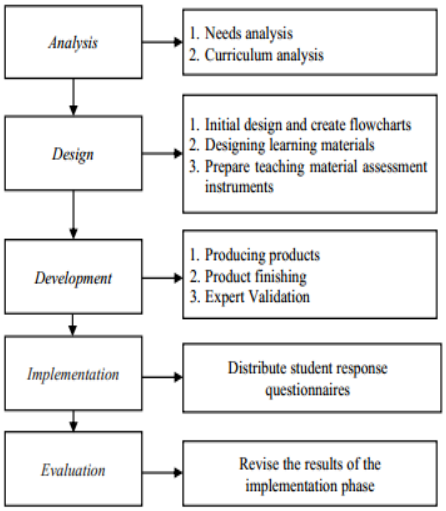


Figure 1 ADDIE model research flow

Data analyzed in the study used a validity questionnaire and learner responses. The validity of educational materials is determined by processing data gained from material experts and media experts through questionnaire instruments (Hufri et al., 2019). While analysing students' responses to instructional materials is carried out by processing data gained from students through questionnaire instruments. A Likert scale with a score of 1-4 on the validator data was initially employed to analyze the data, as Table 1 illustrates.

Table 1 Likert scale criteria for teaching materials

No	Answers	Score
1	Strongly Agree	4
2	Agree	3
3	Disagree	2
4	Strongly Disagree	1

The scores that have been obtained based on the assessments of media and material experts are then converted into percentages using the following formula:

$$p = \frac{v\,1 - v\,2}{v\,1 + v\,2} = \ldots \times 100\% \qquad \ldots (1)$$

Description:
P = Validity percentage
$v1$ = Validator 1's overall score
$v2$ = Validator 2's overall score

After the percentage results are obtained, group them into product validity criteria: if the percentage results are 0.0%–10.0%, declared valid, and if the percentage results are more than 10.0%, declared invalid.

Furthermore, the data obtained from students was analyzed using a Likert scale. The questionnaire for students consisted of 14 positive statements and 13 negative statements, with each answer to the positive statement given the highest score of four and the negative question given a score of one. The questionnaire scoring criteria are presented in the following Table 2.

Table 2 Learner response criteria

Answers	Score	
	Positive	Negative
Strongly Agree	4	1
Agree	3	2
Disagree	2	3
Strongly Disagree	1	4

The scores that have been obtained based on student answers are then converted into a percentage form adapted by Akbar (2013). After obtaining the percentage results, group them into product practicality criteria adapted by Akbar (2013). The product practicality criteria table is as follows:

Table 3 Product practicality criteria for learner response

Validity Criteria	Validity Level
$80\% \leq x \leq 100\%$	Very Practical
$60\% \leq x < 80\%$	Practical
$40\% \leq x < 60\%$	Not Practical
$00\% \leq x < 20\%$	Not Very Practical

RESULT AND DISCUSSION

The product of this project is physics teaching materials for SMA/MA class X students that discuss pro-environmental global warming. The ADDIE model, which consists of the phases of analysis, design, development, implementation, and evaluation, was the development model employed in this study. The following is a description of the ADDIE phases' outcomes:

Analysis Stage

The analysis stage is conducted to determine learning needs and identify problems that may occur in schools (Magdalena et al., 2020; Martatiyana et al., 2023; Rahmandhani & Utami, 2022). The analysis stage is divided into two steps: needs analysis and curriculum analysis. The first step is a needs analysis by directly interviewing the class X physics teacher at SMA Negeri 1 Kota Bangun about the school, the number of students, the difficulties experienced by students, and the teaching materials used at school.

The second step is curriculum analysis. By conducting curriculum analysis, we can adjust the curriculum applied to the teaching materials (Nurhasanah et al., 2021). The results of the curriculum analysis show that schools use an independent curriculum. During observations, students use teaching materials from the government that do not link the material to problems that exist in everyday life, especially global warming material. This material has learning objectives: Students analyze the symptoms of global warming events and propose ideas for solving global warming problems related to their symptoms and impacts on life and the environment. This analysis is done by adjusting the learning outcomes to formulate learning objective indicators.

Design Stage

The findings of the analysis stage are used as the basis for the design stage. The design stage begins with creating a flowchart of teaching materials. A flow diagram is a chart that shows the flow and contains a sequence of steps to meet students' needs so that teaching materials are easy to understand (Awandany &

Budiastuti, 2020). The second stage is preparing an initial design of teaching materials by designing global warming learning materials. Material obtained from several references is arranged sequentially and integrated in Microsoft Word.

Next, an assessment instrument for the teaching materials that have been made must be prepared. Three instruments are used to assess teaching materials: student response surveys, media validation surveys, and material validation questionnaires. According to Farhana et al. (2021), a questionnaire displays the percentage of interest and obtains responses or answers to the information needed from the questions compiled.

Development Stage

Producing Teaching Materials

This stage begins by creating a design layout for teaching materials. The format used is attractive for students. Teaching materials are also equipped with illustrations that follow the students' environment. After the layout design is complete, proceed with inputting the material compiled in the previous stage. Then, enter the process of editing the appearance of teaching materials. Teaching materials have three parts: the initial, the content, and the final.

Validation of Teaching Materials

After the teaching material editing process is complete, the material product is tested for validity in both the material and media aspects. Validity is measured to determine the relevance of teaching materials and learning media to the curriculum based on validator notes and comments (Asri & Dwiningsih, 2022; Hartini et al., 2019). Two lecturers of Physics Education at FKIP Universitas Mulawarman and one physics teacher are expert validators on material and media aspects.

The material validity test questionnaire consists of four aspects: content feasibility, presentation feasibility, language, and pro-environment. Furthermore, the media feasibility test questionnaire consists of two aspects: graphic feasibility and electronic media feasibility. The results of the material experts' validation are presented in Table 4.

Table 4 Material expert validation results

Assessment Component	**V1**	**V2**	***P*%**	**Category**
Content Appropriateness	32	33	1.5	Valid
Presentation Feasibility	22	22	0.0	Valid
Language	13	15	7.1	Valid
Pro-environment	24	24	0.0	Valid
Material Validity	91	94	1.6	Valid

The validation results obtained from the aspect of the material on the teaching materials developed get a percentage of 1.6% with the valid category, the assessment of the validity test of the material on teaching materials which has several aspects of assessing the validity of teaching material products consisting of 4 indicators, namely the first feasibility of content in accordance with the independent curriculum getting a percentage score of 5% (valid), the second feasibility of presentation which gets the same score from both validators indicating that the presentation of teaching materials is coherent from the easy and difficult ones, so that it gets a percentage score of 0.0% (valid), then the linguistic aspects used in teaching materials are correct in terms of linguistic rules getting a percentage score of 7.1% (valid), and the last is the pro-environmental aspect which has the same score by both validators so that the percentage obtained is 0.0% (valid) which indicates that the teaching materials developed already contain the expected pro-environmental content.

Furthermore, media validation for physics teaching materials can be seen in Table 5.

Table 5 Media expert validation results

Assessment Component	V1	V2	*P*(%)	Category
Graphics	28	30	3.4	Valid
Electronic Media	19	23	9.5	Valid
Media Validity	47	53	6.0	Valid

The assessment of the validity of teaching material products in the media aspect consists of two indicators: graphics and electronic media. The graphical indicator aims to assess visual satisfaction with the size of teaching materials, cover design, and content design of teaching materials. The percentage score on the grammatical feasibility indicator is 3.4% (valid). Electronic media indicators aim to assess the use of software, visual communication, and audio communication. The percentage score on the electronic media feasibility indicator is 9.5% (valid). The percentage result of media validation is 6.0%, a valid category.

Implementation Stage

The implementation stage was carried out at SMA Negeri 1 Kota Bangun, which was carried out in class X-1, totalling 33 students, with 14 male and 19 female students. The purpose of providing pre-made and valid teaching materials is to determine students' reactions to the material. Furthermore, teaching materials are distributed to students, and observations are made. Then, students are given a questionnaire to determine their responses to the teaching materials (Kane et al., 2016). Questionnaires that students filled out were analyzed and used as evaluation material. The analysis of student responses can be seen in Table 6.

Table 6 Results of learner response

Aspect	Percentage	Category
Ease of use	84%	Very Practical
Attraction	85%	Very Practical
Efficiency	75%	Practical
Pro-Environment	86%	Very Practical
Learner Response	**85%**	**Very Practical**

Based on Table 6, the learner response questionnaire data analysis shows that the percentage score of the learner response is 85%, a very practical category. This result is obtained from the results of the score of each aspect, first in the aspect of ease of use, getting a percentage score of 84%, and second in attractiveness, earning a percentage score of 85%. Efficiency got a percentage score of 75%, and pro-environment got a percentage score of 86%. The results obtained are similar to research (Baga et al., 2022) entitled "Pro-Environmental Behavior of Learners Based on Lesson Media." The test results prove a positive response between learning and media towards the environment. The graph of the learners' responses to each aspect is seen in Figure 2.

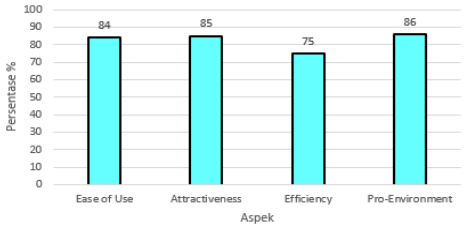


Figure 2 Percentage of learner response results

Based on Figure 2, the percentage scores on each aspect are 84%, 85%, 75%, and 86%. The pro-environmental aspect gets the highest percentage score compared to other aspects, with a percentage score of 86%. This result is because it gets a large enough percentage

on question item P20, namely, 13 strongly agree and 20 agree. Media such as teaching materials are one way for someone to obtain the knowledge they want (Ricciardelli et al., 2021). Based on the response results, it was found that teaching materials already contain pro-environmental aspects. The ease of use aspect received a percentage of 84%. Next is the attractiveness aspect, with a percentage score of 85%. The last is efficiency, with the lowest percentage score of 75%. This result is because only one question item affects the percentage of results obtained. Based on the results of student responses, there are notes of comments on the teaching materials developed, namely structured explanations, colours, and pictures that are interesting to read.

Evaluation Stage

After the implementation stage, the next stage is the evaluation stage. The evaluation stage is divided into two parts: evaluation from validators and evaluation from students' responses. Validator evaluation is carried out after the teaching materials are tested for validity through questionnaires on material and media aspects. Validators added input and suggestions for improvement to the teaching materials developed. The evaluation stage provides assessment and feedback on teaching materials so that teaching materials can be continuously revised and modified based on input from validators (Farhana et al., 2021). Input and suggestions from validators are made to make the developed products feasible and meet the curriculum standards. Viable teaching materials are then tested in the field to see students' responses to the teaching materials that have been developed. Evaluation of the learners' responses was obtained through the prepared learner response questionnaire. Validator comments and suggestions are presented in Table 7 and Table 8.

Table 7 Material expert validator comments and suggestions

Validator	Comments	Improvements
Validator 1 Lecturer in Physics Education, Universitas Mulawarman	The title and subtitle are in different colours.	Giving different colours to headings and sub-headings
	Table caption writing improved.	Improved the writing of the table captions
	Add a space between the image description and the primary paragraph.	Increase the separation space between image captions and main paragraphs.
	The format of the bibliography is equalized.	Improving the format of the bibliography
Validator 2 Physics teacher at SMAN 1 Kota Bangun school	The section in the caption on the image is reduced in size	Fixed the size of the caption on the image
	Correct sentences that are not correct	Correct sentences that are not precise

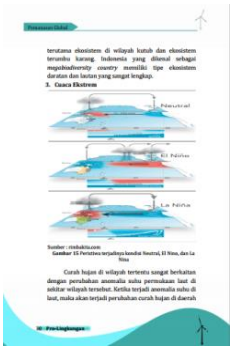
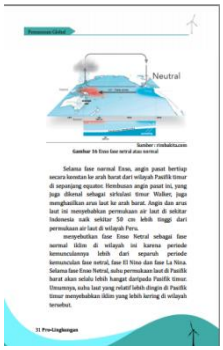
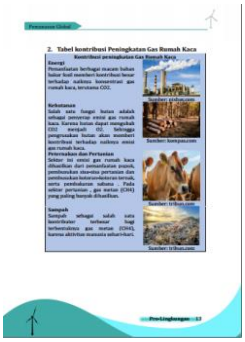
Table 8 Media expert validator comments and suggestions

Validator	Comments	Improvements
Validator 1 Lecturer in Physics Education, Universitas Mulawarman	Improve language and writing in teaching materials	Improve speech and writing in teaching materials
	Correct the editorial	Correct the wrong wording.
	Clarify images that are not clear.	Correct the picture

Validator	Comments	Improvements
Validator 2 Physics teacher at SMAN 1 Kota Bangun school	Correct the wrong sentence	Fixed some wrong sentences
	Improve the writing on the worksheet.	Improve the writing on the worksheet.

Based on the responses and recommendations provided by media and material experts in the validation questionnaire to determine the validity of teaching material (Zainudin & Pambudi, 2019). In Tables 7 and 8, several suggestions for improvement from the validators have been improved, including the type and size of the font on the validation questionnaire. Title, improving language in several paragraphs, and clarifying images.

Table 9 Display of teaching materials before and after repair

Before Repair	After repair	Before Repair	After repair
			
			
			

CONCLUSION

The validity results of developing pro-environmental-based physics teaching materials in the material aspect obtained a percentage of 1.6%, including a valid category. In comparison, the media aspect received a rate of 6%, which is valid. As a result, pro-environment-based physics teaching materials on global warming for class X are feasible and can be used in SMA or MA semester II physics learning.

The response of students in class X-1 SMA Negeri 1 Kota Bangun to physics teaching materials on pro-environment-based global warming obtained an average percentage of 85%, including the very practical category. Based on the results of these responses, this teaching material can be used in the learning process to provide knowledge and understanding about global warming and its relationship with the surrounding environment.

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