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Development of Physics Teaching Materials Based on Sets (Science, Environment, Technology, and Society) to Improve Student Creativity

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Abstract: This research is Research and Development (R&D). The development is carried out by referring to the 4D model. The 4D stages include the define, design, develop and disseminate stages. This development research aims to: produce SETS (science, environment, technology, and society-based physics teaching materials to improve students' creativity that meet valid criteria; produce SETS-based physics teaching materials to improve students' creativity that meet practical criteria; describe the effectiveness of using SETS-based physics teaching materials to improve students' creativity that has been developed. The instruments used in this study were SETS-based teaching material validation sheets, practitioner assessment questionnaires, namely physics subject teachers, and creativity test instruments. The criteria for the practicality of the physics teaching module are seen from the assessment of practitioners (physics teachers), and the criteria for increasing creativity after the application of SETS-based physics teaching materials are seen from the increase in students' creativity test results. Based on the analysis results, it was obtained that: SETS-based physics teaching materials developed based on expert assessment using the Aiken V index analysis were declared valid and feasible to use; SETS-based physics teaching materials reviewed from practitioner assessments were in the very practical category; the effectiveness of increasing student creativity after using SETS-based physics teaching materials analyzed with N-gain of 72% was in the effective criteria.

Keywords: Increasing Creativity; Physics Teaching Materials; SETS-based; Teaching Materials

Introduction

Education is a process of changing behavior, increasing knowledge and life experience so that students become more mature in thinking and attitude (Landberg & Partsch, 2023); (Darling-Hammond et al., 2020). Education in the digital era is very rapid, advances in technology are not only enjoyed by adults, but teenagers can also enjoy the results of current technological developments. Technological developments facilitate the learning process and search for various learning resources, because today's learning is no longer limited by space and time. The use of technology as a learning medium is an effective tool in increasing creativity and problem solving for students (Li et al., 2022); (Haleem et al., 2022); According to (I Nyoman Suparsa et al., 2023); (Berlian et al., 2021), education in the 21st century is a challenge, the world of education has a great responsibility in facing these challenges. The younger generation should have critical thinking skills, creativity and the ability to solve problems in everyday life based on the progress of the 21st century known as the term 6C (critical thinking,

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collaboration, communication, creativity, citizenship, character).

Physics learning is a science that really requires a more complex learning process (Yuliani et al., 2021); (Asmiliyah et al., 2021); (Marcinauskas et al., 2024). Physics cannot be learned just by reading and memorizing content, so creativity is needed in physics learning (Sarwi et al., 2018); (Samani & Pan, 2021). A similar opinion was also expressed by (Sunarti et al., 2020) that the concept of physics by connecting environmental issues, technology, and society, students not only understand the material better but also develop important skills and social awareness that will help them become critical and creative thinkers and responsible citizens.

The above problems obtained that it is important to make new breakthroughs in students' creativity abilities so that the achievement of students' abilities is influenced by the learning process that depends on the teacher's task in creating, designing, and planning a learning resource by paying attention to the characteristics and social environment of students in order to create fun, creative and innovative learning so that learning objectives are achieved in accordance with the demands of the main curriculum in increasing student creativity. One of the learning resources in the learning process that can be developed is SETS-based physics teaching materials that are adjusted to the characteristics of students and the environment (Arisa et al., 2022). This means that the material in the teaching materials developed is not only a general concept but also links the concepts and processes of science (physics) in real life, so that there is concern for the environment and its life.

The results of previous research conducted by (Made Astra et al., 2023); (Arifani et al., 2024), showed that the post-test results showed a significant increase in students' science literacy skills compared to the pre-test results after using SETS-based physics teaching materials. In addition, students provided positive feedback on SETS-based teaching materials, noting that the teaching materials helped understand the relationship between physics concepts and the environment, technology, and society. The development of SETS-based physics teaching materials requires expert assessment to see the feasibility and validity of the modules that have been developed. According to (Schildkamp et al., 2020); (Abubakar et al., 2019); (Szukits & Móricz, 2023); (Tod et al., 2022), assessment is a systematic effort carried out through the collection of reliable data or information in an effort to make considerations for decision making. Each expert is asked to assess the product that has been made to find out the advantages and disadvantages of the product that has been designed (Dwivedi et al., 2021); (Petropoulos et al., 2022).

In addition, according to (Hidayat et al., 2023), the teaching materials developed can be said to be of quality if the three assessments meet the criteria of valid, practical and effective. Teaching materials are suitable for use if the teaching materials have been validated by experts or specialists, responses by practitioners (teachers) and the effectiveness of the teaching materials developed. Based on the description above, the researcher conducted a study entitled "Development of Physics Teaching Materials based on SETS (Science, Environment, Technology, and Society) to Improve Student Creativity".

Method

Type of Research

The research model that will be used in this study is 4-D (four D models). This model was developed by S. Thagarajan, Dorothy S. Semmel, and Melvyn I. The 4D development model consists of four main stages, namely: define; design; develop; disseminate which are carried out to produce SETS-based teaching materials to improve student creativity.

Instruments

The instruments used in this study were validation sheets, practitioner assessment questionnaires, and student creativity test instruments that had been validated by experts and analyzed using the expert agreement index (Aiken's V).

Data Collection Techniques

Expert assessment

The research data collection technique was by providing validation sheets and SETS-based physics teaching materials as well as practitioner assessment questionnaires, and student creativity test instruments to three experts.

Practitioner assessment

Practitioner assessment is by distributing SETS-based physics teaching materials and practitioner assessment sheets to physics subject teachers.

Creativity Ability Test

The creativity ability test of class X.5 students of SMA Negeri 3 Barru was obtained by giving the test twice, namely pretest and posttest.

Data Analysis Technique

Validation data analysis

The analysis used to determine the level of relevance by three experts used the content validity

coefficient (Aiken's V) with the formula (Retnawati, 2012) as follows:

$$V = \frac{\sum s}{n\,(c-1)} \quad (1)$$

Practitioner Assessment Questionnaire Data Analysis

Analysis of the practitioner assessment questionnaire on SETS-based physics teaching materials developed using the formula according to Riduwan (2018) as follows:

$$\text{Percentage} = \frac{\text{Fixed score per item}}{\text{maximum ideal score amount}}\ x\ 100\% \quad (2)$$

The percentage of practitioner responses for each statement using the criteria according to Table 1 is as follows:

Table 1. Practitioner Assessment Score Categories

Percentage (%)	Criteria
75 < x ≤ 100	Very Practical
50 < x ≤ 75	Practical
25 < x ≤ 50	Less Practical
0 < x ≤ 25	Not Practical

Analysis of the Effectiveness of SETS-Based Physics Teaching Modules

The effectiveness of SETS-based physics teaching materials can be obtained from improving students' analytical thinking skills by using the N-gain score formula. According to Sundayana (2014), the following formula is used to determine the N-gain:

$$Normalized\ Gain\,(G) = \frac{X_{posttest} - X_{pretest}}{X_{\max} - X_{pretest}}\ x100\% \quad (3)$$

The gain index interpretation criteria can be seen in Table 2 as follows:

Table 2. Normalized Gain Criteria

Normalized Gain Value	Interpretation
0.70< g ≤1.00	High
0.30 < X ≤0.70	Medium
0.00 < X ≤0.30	Low

Furthermore, the effectiveness of using SETS-based teaching materials is categorized based on the interpretation of the effectiveness of the N-gain score obtained and then expressed as a percentage (%) as in Table 3 as follows.

Table 3. Interpretation of the Effectiveness of the N-gain Score

Interval %	Category
g ≤ 55	Not Effective
g ≥ 56	Effective

Referring to table 3, it is stated that the use of SETS-based physics teaching materials to improve student creativity is effective if 70% or more students have a gain score ≥ 56% or with effective criteria.

Result and Discussion

Results of Content Validity of SETS-Based Physics Teaching Materials

The aspects of content validity assessed by the three experts are aspects of content feasibility, presentation, language, and graphics. The results of the content validity coefficient analysis test of the expert agreement index with the Aiken's V index analysis are presented in Table 4 below:

Table 4. Results of Content Validation of SETS-Based Physics Teaching Materials

Aspect of Eligibility	Score Acquisition	Ideal Score	%	Validation Index	Information
Content	93	108	86	0.81	valid
Presentation	94	108	87	0.83	valid
Language	104	120	87	0.82	valid
Graphics	123	144	85	0.81	valid

The validity of the product content is carried out by presenting several experts who are experts to assess the new product that has been designed. Each expert or specialist is asked to assess the product that has been made to find out the weaknesses and strengths of the product that has been designed (Puyt et al., 2023); (Seyedhamzeh et al., 2020). The validation analysis that has been carried out is obtained as in Table 4 which states that the SETS-based physics teaching materials are declared valid. SETS-based physics teaching materials that are declared valid mean that the teaching materials as a whole, the material and the components of the teaching materials are related consistently with each other (Astutik & Prahani, 2018).

SETS-based physics teaching materials that are declared valid mean that the SETS-based physics teaching materials as a whole, the material and the components of the teaching materials are related consistently with each other (Battiston et al., 2020). The components in question are the suitability of the content presented with the applicable learning achievements and curriculum (Bao & Koenig, 2019), linking the material to problems that are often encountered in everyday life, using language that is easy to understand. As stated by (Cheung et al., 2024); (Farida & Setiawan, 2022) that a development result (product) is said to be valid if the product is based on adequate theory and all components of the learning product are related consistently with each other.

The results of the validity analysis of the SETS-based physics teaching materials that have been developed show that the teaching materials are feasible or valid. In line with the research conducted (Wati & Syafriani*, 2023) who developed SETS-based physics teaching materials to strengthen students' character values with validity results in the valid category. A similar thing was also done by (Herayanti et al., 2023); who developed inquiry-based physics teaching materials to improve students' creative thinking with expert assessment results in the valid category or feasible for use.

Practitioner Responses to SETS-Based Physics Teaching Materials

The results of the analysis of practitioner assessments of SETS-based physics teaching materials can be seen in the following table 5:

Table 5. Percentage of Practitioner Assessments of SETS-Based Physics Teaching Materials

Aspect of Eligibility	Score Acquisition	Ideal Score	%	Category
Content	307	360	85	Very practical
Presentation	312	360	87	Very practical
Language	307	360	85	Very practical
Graphics	379	440	86	Very practical

The practitioner questionnaire sheet was given to practitioners to view and to assess the implementation and benefits of the developed SETS-based physics teaching materials. Practitioners in this study were physics teachers at the high school/Islamic high school level in Barru Regency, totaling 10 physics teachers. 2 physics teachers came from SMA Negeri 3 Barru and 8 physics teachers came from several high schools throughout Barru Regency.

Based on the results of the practitioner assessment analysis, it was concluded that practitioners on average gave a good assessment to the SETS-based physics teaching materials that were developed. The results of this assessment were supported by practitioners' direct responses when assessing the developed teaching materials. Practitioners provided a lot of input to improve the quality of the developed teaching materials. Practitioners assessed that the SETS aspect of the material needed to be supplemented with topics that were easily found in the students' environment. Another statement item that received a response was the illustration of the material related to the students' real environment.

Effectiveness of SETS-Based Physics Teaching Materials

To obtain the effectiveness of SETS-Based Physics Teaching Materials, an analysis was carried out to improve students' analytical thinking skills using the N-gain score equation (Table 6).

Tabe 6. The results of the N-Gain analysis

Normalized Gain Value	Interpretation	Frequency	%	Criteria			
				Effective	%	Ineffective	%
0.70≤g≤1.00	High	2	7	2	7	-	-
0.30≤g≤0.70	Medium	24	83	19	65	5	18
0.00<g≤0.30	Low	3	10	-	-	3	10
Amount		29	100	21	72	8	28

The effectiveness of SETS-based physics teaching materials can be seen based on the results of the creativity ability test of class X.5 students of SMA Negeri 3 Barru. The creativity ability test was given before and after being given SETS-based physics teaching materials in physics learning. Based on the results of data analysis obtained from the results of student test scores before and after being given SETS-based physics teaching materials. Teaching materials are said to be of quality if they meet the three assessment criteria standards, namely valid, practical, and effective criteria.

The effectiveness of using SETS-based physics materials can be seen based on the results of a limited trial of class X.5 students of SMA Negeri 3 Barru as research subjects on the results of increasing creativity ability tests according o indicators, namely fluency, originality, elaboration, and flexibility. from the results of the test, the results of the posttest analysis increase were obtained. The form of the pretest and posttest result diagrams can be seen in figure 1.

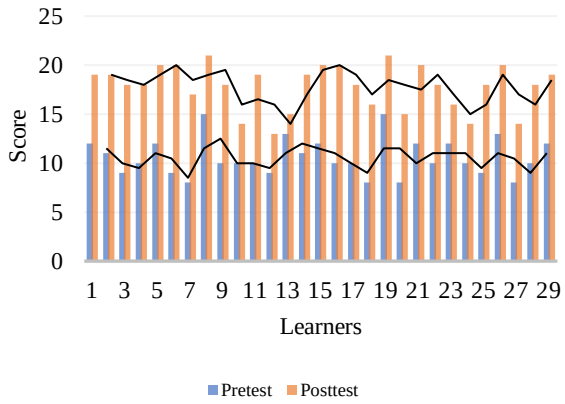

Figure 1. Pretest and Posttest Creativity

The results of the students' tests before and after using SETS-based physics teaching materials, then an N-Gain analysis was carried out to see whether there was an increase in students' creativity. The results of the analysis obtained an average N-Gain value of 0.60. More details can be seen in Appendix D3. This means that there is an increase in students' creativity in the effective criteria (Dwikoranto, 2022); (Pursitasari et al., 2022). Based on this, the SETS-based physics teaching materials that have been developed are effective in increasing students' creativity. This is shown in the activeness of students in the learning process using the SETS-based physics teaching materials that have been developed (Banda & Nzabahimana, 2023); (Parker et al., 2022).

SETS-based physics teaching materials have many roles as learning resources that contain activities involving science and technology, concepts that can stimulate students to solve everyday life problems through the role of physics (Sundari et al., 2024), especially in making products related to the material that has been taught. Basic questions are presented in the form of discussions that invite students to think creatively so that learning is more interactive, students are active in understanding the concepts given, so that students' learning motivation in learning can increase (Gitadewi et al., 2022).

In SETS-based physics teaching materials, the material is presented in the form of text, images that are able to visualize the material clearly, website links are provided for several learning resources related to the material as additional references, and are equipped with sample questions and practice questions at the end of the learning activity that can hone the abilities, especially the creativity of students (Abdulrahaman et al., 2020). With these teaching materials, the learning process should run more effectively and efficiently and support interaction between teachers and students so that students can understand the concept of the lesson and experience increased student creativity (Ong & Quek, 2023); (Falcon et al., 2023).

Conclusion

Based on the results of the research and trial of SETS-based physics teaching materials, the first conclusion is that the validity of the content of SETS-based physics teaching materials developed based on the results of the Aiken's V content validity coefficient has met the valid category. Second, the responses of practitioners to the SETS-based physics teaching materials developed are in the very practical category. This shows that practitioners give a positive response to the SETS-based physics teaching materials developed. Third, the effectiveness of the use of SETS-based physics teaching materials to improve student creativity analyzed by the N-gain score is obtained in the moderate category. This shows that there is an increase in the physics creativity of students at SMA Negeri 3 Barru and the teaching materials developed are declared effective for use in learning.

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Author Contributions

Zulfaniar conceptualized the research idea, research method, and analyzed the data.
Muhammad Arsyad and Pariabti Palloan; guided the writing of the review and editing, supervised and validated the instruments used in the research.

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Conflicts of Interest

The author declares no conflict of interest.

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