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Development of the Base Physics (BASIC) Website to Improve High School Physics Science Literacy in the Merdeka Curriculum

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Abstract

This study developed a website-based learning media, Base Physics (BASIC), to improve high school students' science literacy in physics following the Merdeka Curriculum. The Research and Development (R&D) method was used with the 4-D model (Define, Design, Develop, Disseminate). This media is designed to overcome the limitations of learning resources and provide additional references that are interactive and easily accessible. This study involved 35 students of class XII IPA at SMAN 6 Serang City and three expert validators who assessed the aspects of content, Design, and language. The validation results showed BASIC had a feasibility level of 96%, while the limited trial obtained positive responses from students with a percentage of 82%. This media is recognised for improving understanding of physics concepts, scientific thinking skills, and student engagement in learning. Thus, BASIC can be an innovative learning medium that supports physics science literacy in schools. This research recommends further development in Design and material coverage and evaluation of its effectiveness on student learning outcomes.

INTRODUCTION

The Programme for International Student Assessment (PISA) is an international organisation that assesses learners' literacy skills. PISA emphasises the importance of science literacy, which includes scientific knowledge and its use to identify questions, acquire new knowledge, explain scientific phenomena and draw conclusions from questions. Science literacy is one of the main objectives of learning science, including physics. However, the PISA assessment shows that the science literacy of Indonesian students is still concerning. In 2019, according to the OECD report, Indonesian students' science literacy ranking was 62nd out of 70 participating countries. The main weakness lies in the in-depth understanding of scientific concepts and applying science in real situations. This low science literacy impacts the lack of students' ability to relate physics theories to everyday life phenomena [1] . Science literacy is important for students to deal with scientific problems, issues, and growing technological phenomena [2] . Limited facilities are one of the urgencies that are increasing interest in science literacy. An interview at a high school in Serang City showed a lack of learning media that supports science literacy, especially in physics. Technological advances offer opportunities for innovation in learning media. However, many teachers have been unable to utilise or create innovative learning media and still use conventional methods. 21st-century teachers must have the ability to be good teachers and learners, as well as agents of change that improve the

quality of learning [3] . Website-based learning media can be a practical alternative because it can be accessed via a PC or mobile device. In line with the independent curriculum that emphasises the development of soft skills, character, and flexibility of learning, learning websites can be used as teaching and evaluation materials. One solution to improve science literacy is through website-based learning media. Unlike static textbooks or one-way learning videos, websites allow more flexible interaction with the material, including simulations, interactive quizzes, and multimedia integration that supports understanding abstract concepts in physics [4].

Previous studies have developed technology-based learning media, such as Android applications (Rozi & Kristari, 2020) and Construct 2-based educational games (Arisandy & Marzal, 2021). However, these studies have not specifically targeted the improvement of science literacy in physics learning in the Merdeka Curriculum. Therefore, this research focuses on developing a Base Physics (BASIC) Website to address gaps in understanding physics concepts and improve students' scientific thinking skills. The author proposes using the website as a learning medium to support students in self-study and as an addition to learning at school.

RESEARCH METHODS

The research method used in this study is Research and Development (R&D). According to Sugiyono (2017) in his book "Research and Development," R&D is a research method used to create or innovate products and test the effectiveness of these products [5] . This research focuses on product development through website-based learning media for physics materials in the independent curriculum focusing on science literacy. This research design refers to several stages in the development research model. The research model used is the 4-D model developed by Thiagarajan et al. (1974), which consists of four stages: define, Design, develop, and disseminate [6].

This study's subjects were 35 students of class XII IPA at SMAN 6 Serang City selected by purposive sampling method. These students studied physics material according to the scope of the BASIC website. Expert Validators consist of 1 physics lecturer and 2 physics teachers experienced in developing learning media. In addition, three expert validators will assess the feasibility of this learning media, including the content of grade 11 physics material, the relevance of daily life phenomena to the material, and the Design and quality of website-based learning media.

This research was conducted at SMA Negeri 6 Kota Serang, Cipocok District, Kota Serang, Banten Province, in the 2023/2024 academic year. This research instrument includes assessment sheets from media and material experts on BASIC (Base Physics) Website learning media based on standards from the Ministry of Education and Culture's Education Information and Communication Technology Centre, as well as student response sheets to obtain user response data using the Technology Acceptance Model (TAM) model.

1. Material and Media Expert Instruments

   The validation instrument for material experts is a questionnaire developed by researchers to measure the feasibility of material on the BASIC (Base Physics) website media. Table 1 lists aspects of the material expert assessment.

Table 1. Media and Material Expert Instrument Lattice

No.	Research aspects	Research Scale				
		1	2	3	4	5
1	Correctness of material content					
2	Free of conceptual errors					
3	Currentity of the material					
4	Coverage and depth of material					
5	Relevance (reference point) used					

2. User Instrument

   This questionnaire instrument is a student response sheet to collect data on user responses to BASIC (Base Physics) website learning media using TAM. The assessment aspects include the usefulness of BASIC (Base Physics), ease of use, comfort of use, attitude towards use, and purpose.

The procedure for developing BASIC (Base Physics) website-based learning media in this study follows the 4D development model, which consists of four stages:

1. *Define* Stage
   This stage was conducted to analyse the needs through interviews with teachers and observations of physics learning in high school.
2. *Design* Stage
   Media design includes making storyboards, selecting interface designs, and preparing science literacy-based physics material content.
3. *Development* Stage
   This stage involves implementing the website that has been designed, by making several revisions based on input from the supervisor. This stage includes expert validation, stage 1 product revision, development trials, and stage 2 product revision.
4. *Disseminate* Stage
   The media was trialled in physics lessons in the classroom and uploaded for wider access.

This research uses quantitative and qualitative data. Quantitative data was obtained through expert validation questionnaires and student response questionnaires using a Likert scale. Qualitative data was obtained through interviews with teachers and observations in media trials[5]

1. Expert Feasibility Test
   Assessing the feasibility of content, presentation, language, and learning media design, the feasibility test by experts uses a modified Likert scale, with an assessment score between 1 to 5 based on the assessment criteria for each statement. The percentage score is calculated using a formula to determine the feasibility of the product based on the interpretation of the feasibility test criteria.

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

NP = Percentage value of feasibility (%)
n = Number of learner assessment scores for each aspect
N = Total score of each aspect

2. Analysis of Limited Test Response by Students
   Measuring ease of use, comfort, attitude towards use, and effectiveness of the media in improving concept understanding, data from student and teacher response questionnaires were analysed using a Likert scale with a score of 1 to 7.

3. Expert Validation Assessment Criteria Guidelines
   Guidelines for expert validation assessment criteria are presented in the appendix. The score from the feasibility test questionnaire is calculated based on the percentage obtained for each aspect, which is then converted into a qualitative value according to certain criteria.

$$NP = \frac{R}{SM} \times 100\%$$

NP = Percentage value of feasibility (%)
R = The score obtained for each aspect
SM = Maximum Score for each Aspect

RESULTS AND DISCUSSION

This research, entitled "Development of Science Literacy-Based Base Physics (BASIC) Website on Independent Curriculum High School Physics Material," produces website-based learning media. This development was tested on grade XI students. The development model used is the 4D model, which includes the stages of defining (defining), Designing (designing), Developing (developing), and Disseminating (disseminating). According to the leading independent curriculum, the research results

include the development process, feasibility, and limited trial results of BASIC website-based learning media as a physics learning tool for grade XI.

Define stage

The initial stage of this research is material and media needs analysis. The results obtained are as follows:

1. Material Needs Analysis

   The researcher collected information related to physics learning at school through interviews with physics teachers at one of the high schools in Serang City. It was found that students do not understand how physics is applied in everyday life, and teachers still use monotonous learning methods. Students also need fascinating science literacy-based learning media that can be accessed anytime.
2. Media Needs Analysis

   The researcher chose Construct 2 as the leading software for media development. The media design was created using Canva, which edits photos, images, and physics equations. We determined that the hardware needed included laptops and devices that met the minimum standards to run the development software.

Design Stage

The second stage of the 4-D development model is the design stage. At this stage, researchers made a BASE PHYSICS media design consisting of several steps. First, a flowchart and storyboard were made. Second, supporting materials were prepared, including reference materials from various sources, and sorted to make it easier for students to understand physics concepts such as magnetic force. The visual Design was created using Canva, while the media was produced using WordPress. Third, expert validation instruments and student response questionnaires on technology acceptance were also prepared. Researchers then produced BASIC learning media consisting of several main components. The main menu contains information about essential competencies, material instructions, and author profiles. The material menu includes five main themes of grade 11 physics: Vectors, Kinematics, Fluids, Sound Waves, and Temperature Heat and Thermodynamics. Each theme is designed to link physics material with real-life applications, using engaging titles to get students interested in learning more.

The BASE PHYSICS homepage contains various displays designed to support science literacy. For example, the "What is BASIC" homepage explains the functions and uses of BASIC with buttons leading to characteristic pages (Figure 1).

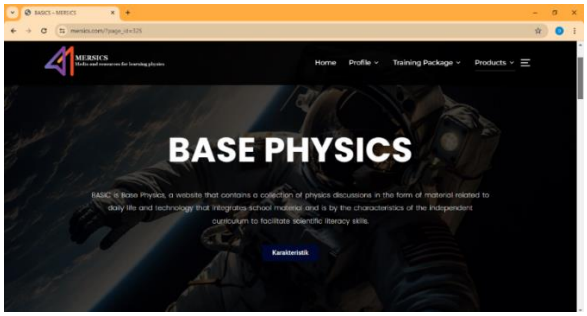

Figure 1. BASIC Home Page

BASIC's characteristic homepage features five main characters that reflect science literacy. There are also instructions for teachers and students, as well as material image headlines covering the main themes of grade 11 physics with catchy titles. In addition, there is a "New Released" page that displays the latest materials and an "About the Author" page that displays the author's profile, complete with biography and contacts (Figure 2).

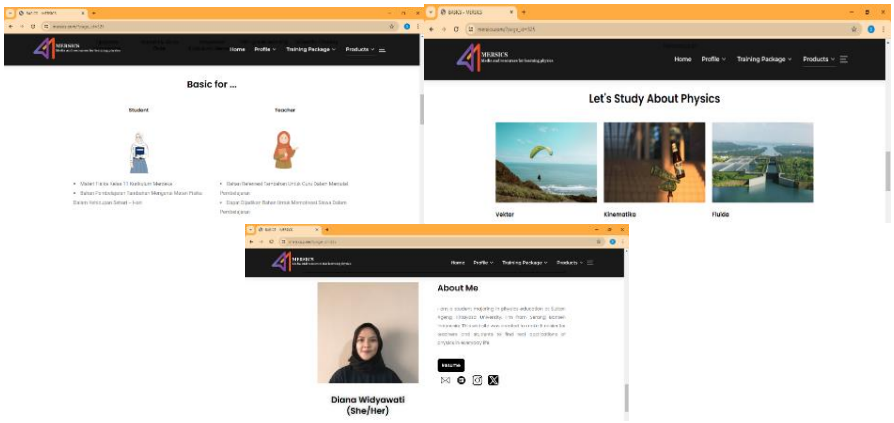

Figure 2. BASIC Homepage

Each page of material comes with in-depth explanations and engaging visuals. For example, the vector material explains how GPS works, the kinematics material discusses the equilibrium of objects, the fluid material describes how the Panama Canal works, the sound wave material explains how sound is heard, and the heat temperature and thermodynamics material answers why planes still use air conditioning. Each material also has a comment column for further interaction (Figure 3).

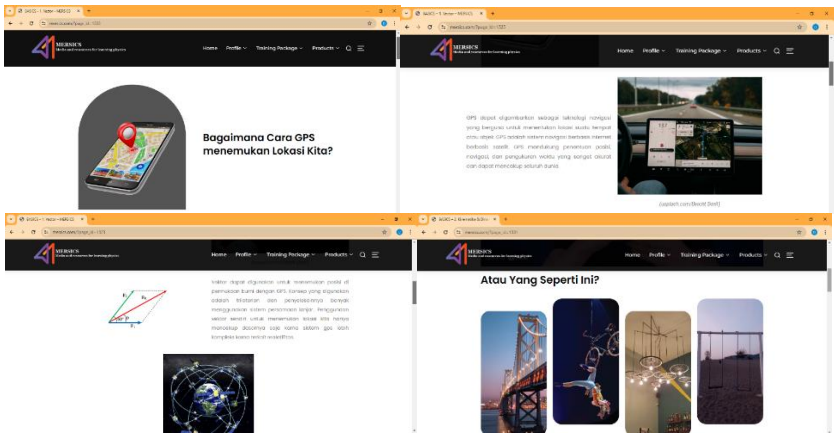

Figure 3. Material Page Display

The BASIC website is designed with characteristics that support science literacy, factual knowledge, and integration with the independent curriculum. Science literacy competencies and principles are applied in all materials presented, making BASE PHYSICS a holistic and contextual learning media.

Development Stage

After producing the initial product, the next stage is development, which aims to assess the feasibility of the learning media that has been designed. The assessment was conducted by three experts, including one lecturer and two teachers, using a validation sheet to test the validity of the developed BASE PHYSICS media. The results of expert validation are presented in Table 3, showing content feasibility (98%), presentation feasibility (94%), language (95%), and design quality (100%), with an overall average percentage of 96%, which is categorised as very feasible (Figure 4).

Table 3. Material and Media Expert Validation Data

No.	Aspects Assessed	Total score per aspect	Total max per-aspect	Percentage	Description
1	Content Appropriateness	49	50	98%	Very good
2	Presentation Feasibility	75	80	94%	Very good
3	Linguistics	19	20	95%	Very good
4	Quality Design	30	30	100%	Very good
	Average Percentage			96%	Very good

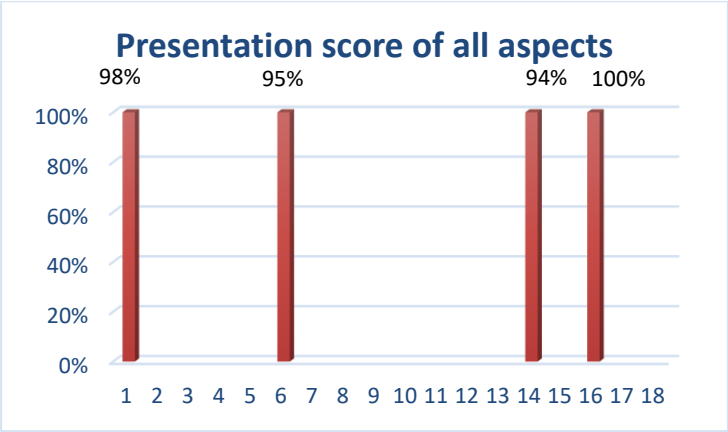

Figure 4: Graph of Material and Media Expert Validation Results

After validation, the experts provided suggestions for improvement which are listed in Table 4.

Table 4. Validators' Suggestions and Improvements

Validator	Comments and Suggestions for Improvement	Before Revision	After Revision
Validator 1	The website is feasible to use and	-	-
Validator 2	Present a physics formula, and add a caption to the presentation of the image shown	There are no physics formulas displayed (only describing physics phenomena through parables and real examples.	Given the physics formula and physics law related to the phenomenon
		Not all images are captioned	Each picture is captioned

After revision based on these suggestions, the researcher conducted a trial on 34 students of class XI Physics at SMA Negeri 6 Serang City. Students were given an explanation of the purpose and how to use BASIC media before trying to use it. The results of the trial were analysed using a student response questionnaire whose results are presented in Table 5.

Table 5. Data Analysis of Learner Response Questionnaire

No.	Assessed Aspect	Total Score Per-Aspect	Total Max Per-Aspect	Percentage	Description
1	Perceived usefulness	600	680	88%	Very good
2	Perceived Ease of Use	403	510	79%	Good
3	Perceived comfort	414	510	81%	Very good
4	Attitude Towards Users	403	510	79%	Good
5	Purpose To Use	264	340	78%	Good
Average Percentage				82%	Very good

The results show an average percentage of 82%, with details of aspects of perceived usefulness (88%), perceived ease of use (79%), perceived comfort (81%), attitude towards use (79%), and intention to use (78%). Based on these results, BASE PHYSICS learning media is considered very good and feasible to use in the physics learning process at school, in line with previous research by Rozi & Kristari (2020) and Arisandy & Marzal (2021) [7],[8] . The developed product has several advantages. Website-based learning media, BASIC (Base Physics), can reduce the limitations of facilities and infrastructure in teaching and learning activities. In addition, BASIC website learning media can be a reference for additional educational learning resources with an attractive appearance, facilitating students' science literacy. This research also faced some limitations. One of the limitations is limited time. In addition, the data collection of student responses was carried out ahead of the final exam at school, so it was necessary to adjust the time of data collection.

This study's results align with Rozi and Kristari's research (2020), which shows that using technology-based media can improve understanding of physics concepts. However, this research explicitly targets science literacy, which has not been widely studied in developing website-based learning media [9], [10] . The high expert validation score on the design aspect (100%) indicates that the website display is by the learning media design standards. However, the student trial score on the ease of use aspect (79%) is lower than others. This may be due to the lack of instructions for the website, so further development is needed in the tutorial or navigation section. This study has several limitations, such as the limited number of samples (35 students), so the results cannot be generalised to a broader population. In addition, this study only measures feasibility and student response but has not tested its impact on improving learning outcomes, which can be the focus of future research. The results of this study indicate that the BASIC website can be an effective alternative learning media for improving science literacy. Therefore, physics teachers can integrate this media into project-based learning. In addition, learning media developers can add interactive simulation features to increase student engagement.

CONCLUSIONS

The results showed that the Base Physics (BASIC) website-based learning media has a very high level of feasibility based on expert validation (96%), especially in the aspects of Design (100%) and content feasibility (98%). In addition, students' responses to this media are also excellent, with a satisfaction level of 82%, which indicates that this website can improve ease of access, concept understanding, and engagement in physics learning. The BASIC media development process followed the 4-D model and produced a science literacy-based interactive learning website successfully. The material coverage in BASIC is still limited to several high school physics topics, so further development is needed to expand the content. The impact of the media on student learning outcomes has not been tested longitudinally, so further research is needed to measure its effectiveness in the long term.

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