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Development of PBL-Based Physics Learning E-Module on Mechanical Wave Material in Class XI

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Abstract

This research aims to (1) produce a physics module on the topic of Mechanical Waves that meets the criteria of validity, practicality, and effectiveness for implementation in the physics learning process, (2) determine the validity level of the physics learning e-module based on Problem Based Learning on the topic of Mechanical Waves for 11th-grade students at SMA Negeri 11 Medan, (3) determine the practicality level of the physics learning e-module based on Problem Based Learning on the topic of Mechanical Waves for 11th-grade students at SMA Negeri 11 Medan, (4) determine the effectiveness level of the physics learning e-module based on Problem Based Learning on the topic of Mechanical Waves for 11th-grade students at SMA Negeri 11 Medan. The subjects of this research were 32 students of class XI MIA 3 at SMA Negeri 11 Medan. This study employed the Research and Development (R&D) method using the ADDIE model (Analysis, Design, Development, Implementation and Evaluation). The instruments used in this research consisted of expert validation questionnaires, media expert validation questionnaires, questionnaires on student responses to the physics learning module based on Problem Based Learning on the topic of Mechanical Waves for 11th-grade students at SMA, and a test instrument. The data analysis technique used in this research was descriptive analysis. The results of this research are as follows: (1) a physics module on the topic of Mechanical Waves based on Problem Based Learning has been developed and validated by two experts with excellent validity, (2) the practicality level of the physics module on the topic of Mechanical Waves based on Problem Based Learning that has been developed is highly practical, (3) the effectiveness level of the physics module on the topic of Mechanical Waves based on Problem Based Learning that has been developed is categorized as moderate.

Keywords: Development, e-module, Problem Based Learning, Mechanical Waves.

INTRODUCTION

The 21st century is the era of globalization in which the development of science and technology is developing very rapidly. Current developments require human resources that are qualified, intelligent, and have the ability to process information so that it can be used to utilize Science, Technology and Art (IPTEKS). Education plays an important role in facing the era of globalization to produce Human Resources (HR).

According to Rusman (in Sulistiyono, 2022), education is an effort made consciously and deliberately to change human behavior both individually and in groups to mature humans through teaching and training efforts. Learning is a process of introducing knowledge that has been designed by the teacher to develop the potential of students so that they acquire knowledge effectively with optimal results.

Physics is a branch of science that studies various phenomena or physical symptoms that occur in the universe. Physics is often expressed in a mathematical form that has a certain physical meaning. So learning physics cannot be separated from mastering concepts, solving problems and applying them in real life. Learning physics as a process means that students are not only given the principles/concepts of a material, but rather the process of obtaining physics principles or concepts. The framework for thinking about physics learning will be easier to understand when learning is carried out with real learning activities so that students get direct learning experience (Sulistiyono, 2022).

To maximize the learning process in conveying concepts and theories, teachers need to implement authentic learning. Authentic learning is a learning process that uses problems from the real world and inspires students to explore and discuss these problems in ways that are relevant to them. In accordance with Donovan and Pallegrino (in Roestiyah, 2019: 39) states that authentic learning is a pedagogical approach that allows students to explore, discuss and meaningfully form concepts and relationships in the context of involving the real world, problems, and projects that are relevant to students.

Based on the results of initial observations at SMA Negeri 11 Medan, located on Jl. Pertiwi, Medan Tembung District using a questionnaire obtained the results of answers given by students that learning was not fully teacher-centered, practicum at the end of each chapter was carried out in the laboratory and virtual through Phet Colorado, there were exercises to evaluate learning, the use of learning media that could be accessed through gadgets, students always used the gadgets they had to help them learn, and there were still many students having difficulty learning a material. So that you get a picture that students are no longer passive in learning and students are able to learn independently by using the gadgets they have, but besides that they are still inseparable from students' difficulties in learning the material. These results are related to the nature of the 2013 curriculum which requires students to be active and able to demonstrate knowledge of the material being studied. The Problem Based Learning learning model is a learning model with a student learning approach to authentic problems so that students can construct their own knowledge, develop higher skills, make students independent and increase their self-confidence. According to Arends (in Holland, 2012: 294).

METHOD

This research was conducted at SMA Negeri 11 Medan. The subjects in this study were students of class XI MIA 3 SMA Negeri 11 Medan, totaling 32 students. This type of research is

research development or Research and Development (R&D) using the ADDIE model (Analysis, Design, Development, Implementation and Evaluation). The instruments used in this study consisted of material expert validation questionnaires, media experts, student response questionnaires to the Problem Based Learning physics learning module on Mechanical Wave material for class XI SMA and test instruments. The data analysis technique used in this research is descriptive.

1. Analysis

At this stage, the development of media and teaching materials needs to be carried out in the process of analyzing both the feasibility of the content and the process. In this section, the analysis that researchers will do in schools is as follows:

a) Analyzing the availability of PBL-based teaching materials, especially PBL-based modules in class XI SMA Negeri 11 Medan
b) Analyze Curriculum is carried out by paying attention to the characteristics of the curriculum being used in SMA Negeri 17 Medan

2. Design

The design or design stage is the researcher analyzing the learning content, selecting teaching materials, and making learning plots (storyboards). At this stage the authors begin to design modules that will be developed in accordance with the results of the analysis carried out in the previous stage. Furthermore, the design stage is carried out by determining the elements needed in the module such as determining the theme, design, images, and materials. The author also collects references that will be used in developing materials in module teaching materials.

3. Development

In the process of making modules made using the Microsoft Word application. The steps for making a module are: 1) making a module using ms.word to make it easier to create and edit text and images; 2) In preparing the contents of the module in the form of material, practicum, and practice questions; 3) After finishing creating the module, the module is saved in pdf format and ready to use.

After the module has been created, the module will be validated by expert lecturers and teachers. In the validation process, the validator uses instruments that have been prepared at the design stage. The validator was asked to provide an assessment of the module being developed based on the feasibility aspects of the module and provide suggestions and comments related to the contents of the module which will later be used as a benchmark for revisions to

improvements and improvements to the module. The validity test is carried out until at the end of the module it is declared feasible to be implemented in learning activities.

4. Implementation

The implementation stage is the stage of doing the learning. At this stage it was carried out at schools designated as research sites and researchers also used modules in the learning process for students. After the researcher conducted learning using the module, students filled out a student response questionnaire to the developed module to find out how students responded to learning using the module. So that from the questionnaire information was obtained about the increase in the module development carried out and the data obtained at this stage is the data used to measure the effectiveness and practicality of the module. In addition, data analysis was carried out to measure the validity, practicality, and effectiveness of the developed modules.

5. Evaluation

The last stage of the ADDIE model is the evaluation stage, where at this stage the author makes the final revision of the module being developed. It is intended that modules be developed in accordance with unmet needs and can be used by schools.

RESULTS AND DISCUSSION

Result

1. Analysis

The analysis stage is the initial stage in preparing the e-module. The development of e-modules is carried out after conducting an analysis of student needs. The student needs analysis stage is carried out to find out the types of e-modules that students can use according to the needs and characteristics of students at school. What is obtained at this stage through observation is that there are still limited independent teaching materials for students.

2. Design

Selection of font type and font size is the first step in e-module development. A4 (21 X 29.7) is the size of the letters used in the production of problem-based learning-based Mechanical Wave Physics e-modules. "Times New Roman" at 14 pt is the font used for the content.

3. Development

The development phase is the phase in which the product is implemented according to the plans that have been made before. Researchers verify the products developed at this stage. Then the validator evaluates the e-module. The validators in the module development process were Mr. Abdul Rais S.Pd, S.T, M.Si and Mr. Irham Ramadhani S.Pd, M.Pd.

Tabel 1 Saran Perbaikan E-Modul Oleh Ahli Materi

Indikator	**Jenis Kesalahan**	**Saran Perbaikan**
Kelayakan Penyajian	Penulisan rumus disertakan penomoran, tidak tersedia kesimpulan, dan daftar pustaka.	Menambahkan penomoran pada setiap rumus serta melengkapi kesimpulan dan daftar pustaka.
Penilaian Kebahasaan	Terdapat kesalahan penulisan kata dan pengejaan.	Memperhatikan setiap kata yang ada dan menyesuaikannya dengan kaidah kebahasaan.

Tabel 2 Data Hasil Validasi Materi

No	**Aspek**	**Persentase**	**Kriteria**
1	Kelayakan isi	98%	Sangat baik/valid
2	Kelayakan penyajian	98%	Sangat baik/valid
3	Penilaian bahasa	97%	Sangat baik/valid
Rata-rata		97%	Sangat baik/valid

Tabel 3 Saran Perbaikan E-Modul Oleh Ahli Media

Indikator	**Jenis Kesalahan**	**Saran Perbaikan**
Kelayakan Penyajian	Cover e-modul tidak menggambarkan materi, tata letak, warna terlihat kurang menarik, dan minimnya iustrasi.	Memilih gambar yang sesuai untuk dijadikan cover, meberikan variasi warna untuk menambah daya tarik pada modul, dan ilustrasi diberikan pada materi yang dibahas.
Kelengkapan Isi	Soal-soal evaluasi pada akhir sub bab.	Membuat soal evaluasi diakhir sub bab.

Tabel 4 Data Hasil Validasi Media

No	**Aspek**	**Persentase**	**Kriteria**
1.	Kegrafikan	80%	Sangat baik/valid
2.	Desain isi	90%	Sangat baik/valid
Rata-rata		85%	Sangat baik/valid

4. Implementation

The stage that is carried out after conducting revisions and improvements by material experts and media experts is the implementation stage. This stage is carried out in 2 stages, namely the practicality test and the effectiveness test.

a) Assessment of Product Practicality Based on Student Responses

Tabel 5 Hasil Respon Siswa Kelompok Kecil

No	**Aspek**	**Persentase**	**Kriteria**
1.	Kelayakan Isi	91,39%	Sangat praktis
2.	Kelayakan Penyajian	92,08%	Sangat praktis
3.	Kesesuaian dengan PBL	94%	Sangat praktis
Rata-rata		92,49%	Sangat praktis

Obtained the response of students to the e-module on the aspect of content feasibility getting a response of 91.39%, on the feasibility aspect of presentation getting a response of 92.08% and on the component aspect of Problem Based Learning getting a response of 94%. In order to obtain the results of the average percentage of student responses to modules developed based on aspects, namely 92.49% with a very practical category.

Tabel 6 Hasil Respon Siswa Kelompok Besar

No	**Aspek**	**Persentase**	**Kriteria**
1.	Kelayakan Isi	90%	Sangat praktis
2.	Kelayakan Penyajian	91%	Sangat praktis
3.	Kesesuaian dengan PBL	91%	Sangat praktis
Rata-rata		90,6%	Sangat praktis

The average percentage of responses from the questionnaire given to students was 90.6%, as shown in the table. The average percentage of content on the material eligibility element is 90%, the average proportion of presentation of criteria is 91%, and 91%, on the suitability aspect. Judging from the percentage of student responses to e-modules, it can be shown that these categories are very practical and can be applied in learning activities.

Tabel 7 Hasil Respon Angket Guru

No	Nama Guru	Jumlah Skor	Persenatse Kepraktisan	Kriteria
1	Enti Siahaan, S.Pd	75	98,7%	Sangat praktis

Assessment by the teacher is emphasized on aspects of appearance, presentation of material and ease of use of teaching materials. Based on table 4.11 it can be seen that the percentage value of the teacher's response to the developed module is 98.7%. Thus, based on these three aspects, it was found that the teacher gave a score of 98.7%, which means that the teaching materials developed were very practical to use.

b) E-Module Effectiveness

The level of effectiveness of the mechanical wave e-module material was obtained from the test results and was carried out on students in a large group test of 32 students. The test results were from the results of the students' pre and post tests. The results of the analysis are determined based on the pre and post tests in a test consisting of 10 multiple choice questions, after which the results are known from the confirmation values of the pre and post test results. The summary of the results before and after the test is shown in table.

Tabel 7 Hasil Analisis Pretes dan Postes

Nilai	**Skor Rata-rata**	**N-Gain**	**Kategori**
Pretest	54,7	0,697	Sedang
Posttest	86,6		

The post-test mean increased from the pre-test results to n-gain 0.697 in the middle class, according to the results of the analysis above indicating that the developed e-modules are effectively used in learning activities to improve students' abilities. learning outcomes.

5. Evaluation

Obtained from the results of validation by expert validators, student responses, teacher questionnaires, and student test results on the e-modules that were developed were categorized as suitable for use. In the e-module there are still deficiencies that must be revised through suggestions from the validator to produce e-modules that are better and very suitable for use during learning.

Discussion

The development of Physics learning media carried out by researchers is able to assist teachers in delivering learning material if they cannot teach students directly, are able to create enthusiasm for student learning, learning becomes not rigid. Then the media developed is based on Problem Based Learning (PBL) which guides students to solve the problems that have been provided. The research that the authors have developed for validation by material experts is 97% with very good/valid criteria but there are some that need to be revised, in the media section getting a value of 85% with very good/valid criteria.

The level of practicality obtained from the development of the PBL module in small group tests and large group tests on designed electronic modules, criteria that are very practical in large groups with an average score of 90.6%. the percentage of teachers' responses to the developed module was 98.7%. This percentage has very practical criteria, with these percentages and criteria the modules developed are useful and suitable for use in learning.

The developed module is effective with an increase in the average value of the initial and final tests and obtained an N-gain of 0.697 which is in the medium category.

CONCLUSION

Based on the results of research and discussion, the conclusions that can be obtained in this study are as follows:

The physics learning e-module on mechanical wave material which was developed through the ADDIE stage (Analysis, Design, Development, Implementation, Evaluation) was concluded to be suitable for use in learning based on the feasibility test validation by media experts of 85% with the category very feasible but there are some that need to be revised, in the material section it scores 97% with the category very feasible, but directions are given to pay attention to writing, formula numbering and giving evaluation questions.

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BIBLIOGRAPHY

Agustina, H., A, S., Susilawati, & Gunada, I. W. (2022, September). Pengaruh Penggunaan Modul Fisika Berbasis Problem Based Learning Terhadap Kemampuan Berpikir Kritis Peserta Didik. *Jurnal Ilmiah Profesi Pendidikan, 07*.

Algiranto. (2022). Pengembangan Modul Pembelajaran Fisika Berbasis Discovery Learning Untuk Siswa SMA. *Jurnal Perspektif Pendidikan, 16*.

Amaliyah, R., Hakim, L., & Lefudin. (2023). Pengembangan Modul Pembelajaran Fisika Berbasis Problem Based Learning Untuk Meningkatkan Minat dan Hasil Belajar Peserta Didik Kelas X di SMA. *Jurnal Kumparan Fisika, 6*, 65-74.

Butar-butar, Y., & Panggabean, D. D. (2022, Mei). Pengembangan E-Modul Pembelajaran Fisika Berbasis Problem Based Learning (PBL) Pada Materi Hukum Newton Gerak Kelas XI Di SMA Negeri 1 Besitang. *Jurnal Inovasi Pembelajaran Fisika, 10*, 84-91.

Fahrurrozi, M., & Mohzana. (2020). *Pengembangan Perangkat Pembelajaran.* Lombok, Nusa Tenggara Barat, Indonesia: Universitas Hamzanwadi Press.

Hartata, R. (2020). *Meningkatkan Motivasi dan Prestasi Belajar Sejarah Dengan Problem Based Learning (PBL).* Klaten, Jawa Tengah, Indonesia: Lakeisha.

Juliarti, L., Sutrio, & Taufik, M. (2022). Pengembangan Modul Momentum dan Impuls Berbasis Problem Based Learning Untuk Meningkatkan Kemampuan Pemecahan Masalah Peserta Didik. *Jurnal Hasil Kajian, Inovasi, dan Aplikasi Pendidikan Fisika, 8*.

Kamajaya, K., & Purnama, W. (2016). *Aktif dan Kreatif Fisika.* Bandung, Indonesia: Grafindo.

Kurniawan, C., & Kuswandi, D. (2021). *Pengembangan E-Modul.* Lamongan, Indonesia: Academia Publication.