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DEVELOPMENT OF A PROBLEM BASED LEARNING ORIENTED PHYSICS E-MODULE TO IMPROVE THE SCIENTIFIC LITERACY OF HIGH SCHOOL STUDENTS

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Abstract

This study aims to: 1) develop a problem-based learning-oriented physics e-module to improve the science literacy of high school students, 2) determine the feasibility of the e-module, 3) determine students' perceptions of the e-module. The method used in this study is Research and Development (R&D) using the ADDIE (Analysis, Design, Development, Implementation, Evaluation) model. However, this research was carried out limited to only the Development stage because limited research time, research costs, and adjustments to the needs of development research. The research instruments used are: 1) validation sheets of material experts, media experts, and learning design experts to find out the feasibility of the e-module being developed, 2) Student perception questionnaire to find out students' responses to the developed e-module. The results of this study showed that the results of the validation test received an average assessment of all aspects for material experts of 97.47% with very decent categories, media experts of 92.61% with very decent categories, and learning design experts of 96.52% with very decent categories and for student perception results obtained an average of all aspects of 94.23% with excellent categories. Based on the results of expert validation tests and the results of students' perceptions, it can be concluded that the products developed are decent for use as a medium for learning physics in schools.

Keywords: *E-Modules, Problem Based Learning, Science Literacy*

INTRODUCTION

Physics is a branch of natural sciences, and is a science that is born and develops through the steps of observation, problem formulation, hypothesis preparation, hypothesis testing through experiments, drawing conclusions, and discovering theories and concepts (Nurmayani et al., 2018). Learning physics cannot be separated from mastering concepts, applying them to solving physics problems, and working scientifically (Hudha et al., 2017). The objects of study in physics

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learning are non-living objects and natural phenomena or events which are related to one another so that there are several concepts that are abstract and difficult for students to understand. Educators need to pay attention to these problems so that the learning process can be in accordance with the actual objectives (Rizaldi et al., 2020)

In its implementation, physics learning focuses on processes and attitudes. However, quite a few processes that take place in schools tend to be teacher centered. The student centered approach involves students actively learning with teacher guidance, while the teacher centered approach encourages students to be passive in the learning process. This is what needs to be changed by making students the center of learning (student centered) so that students can play an active role in the learning process (Novita et al., 2016). Meaningful learning emphasizes active involvement and providing direct experience (Ariana et al., 2020). One learning model that actively involves students is the Problem Based Learning (PBL) learning model (Paradina & Medriati, 2019). PBL is a process of independent exploration, not a process of passive information transfer (Houghton, 2023). PBL helps students build reasoning and communication so that students can compete in the 21st century. In addition, PBL utilizes the intelligence of individuals, groups and the environment to solve meaningful, relevant and contextual problems in the learning process so that teaching materials are needed that are in accordance with the model (Hudha et al., 2017).

The Problem Based Learning Model is a learning model that presents contextual problems so that students are stimulated in the learning process through knowledge (Yoesoef, 2015). The Problem Based Learning model is a learning model that uses problems to be solved in collecting and discovering new knowledge in learning both individually and in groups (Fatimah et al., 2014). Arends stated that there are 5 phases (stages) that need to be carried out to implement Problem Based Learning. These phases refer to the practical stages carried out in learning activities as follows: 1) Orienting students to the problem, 2) Organizing students to learn, 3) Guiding individual and group investigations, 4) Developing and presenting the results of work, 5) Analyze and evaluate the problem solving process (Kalsum, 2022).

Along with technological developments, there is a combination of print media and computer media in teaching and learning systems. One of them is included in this case with a module which is transformed into a presentation in the form of electronic media which is capable and can be accessed anywhere with good effectiveness, thus giving birth to using the term electronic module or commonly called e-module (Padwa & Erdi, 2021). Students have not used media-based teaching materials such as digital modules or electronic modules, teachers still only use printed books (Puspitasari et al., 2020). Most of the class XI students said that one reason for the difficulty in understanding physics lessons is due to the limited use of teaching materials, so it requires other additional teaching materials of a personal nature to help

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understand physics lessons. Teaching materials are something that contributes greatly to the success of the learning process (Suratman, 2019). The characters of the generation born in the 2000s or what is usually called Generation Z or Global Generation are very sensitive to technology, meaning they have superior abilities in using technology to develop knowledge (Dwiningsih et al., 2018). This great potential should be utilized optimally by teachers so that learning can be carried out in a directed and effective manner. Aydin & Aytekin (2018) states that learning with e-modules students can learn independently. One of the benefits of independent learning is that students can understand important topics better, which will improve their learning process (Oishi, 2020). E-modules can be used by teachers as learning media and as independent teaching materials for students (Shobrina et al., 2020). The use of e-modules can foster creativity and be active in learning (Sidik & Kartika, 2020). E-modules can make learning activities more interactive because the presentation can include animation, images, video or audio (Masruroh & Agustina, 2021).

In the current era of globalization, science learning, especially physics, must be able to form a scientifically literate attitude that has the ability to think scientifically in solving problems. Scientific literacy can be termed scientific literacy skills, namely the ability to understand science, communicate science (orally and in writing), and apply scientific abilities to solve problems so as to have a high attitude and sensitivity towards oneself and one's environment in making decisions based on scientific considerations (Yuyu, 2017). Science education contributes to the development of the ability to understand the most effective ways to use science in everyday life and social responsibility (Dragoş & Mih, 2015). The average scientific literacy of secondary school students is still relatively low (Kurniawati et al., 2019). The ability of Indonesian students for scientific literacy is still in the low category because the scores obtained are below the average PISA completion score. This indicates that Indonesian students have not been able to understand the concepts and processes of science and have not been able to apply the scientific knowledge they have learned in their daily lives (Sutrisna, 2021). Factors causing the low scientific literacy skills of students include (1) Selection of textbooks which are still limited to textbook or text material rather than conducting direct learning as a result of which lessons become boring and students do not understand the lesson material in the context of life, (2) Misconceptions because there is a demand for teachers to complete teaching materials according to curriculum targets, forcing students to accept science concepts which may not yet be fully understood, (3) Non-contextual learning where the emphasis is on understanding basic concepts and the basic understanding of science is not linked to things related to daily life (4) The learning environment and climate, namely the state of school infrastructure, school human resources and the type of organization and school management, have a very significant influence on student literacy achievement (Fuadi et al., 2020).

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Scientific literacy is a topic that is starting to receive a lot of attention in the academic field. This is based on the importance of mastering scientific literacy for each person to solve a problem. One of them is related to scientific literacy in physics learning which is very important in living in the current era of science and technology (Nurhasanah et al., 2020). The OECD (Organization for Economic Co-operation and Development) regularly carries out the Program for International Student Assessment (PISA) every three years. One of the aspects assessed by PISA is students' scientific literacy (Kimianti & Prasetyo, 2019). Scientific literacy indicators were developed from the PISA scientific literacy assessment. In the scientific literacy assessment, PISA does not assess context but assesses knowledge, competencies and attitudes that refer to context (Fathonah & Sarwi, 2020). The assessment of scientific literacy in the form of questions is different from other questions because it has the characteristics of questions, namely: (1) Questions that contain broader concepts because they are not only related to concepts in the curriculum, (2) Questions must contain information or data in various forms of presentation to be processed by students who will answer them, (3) Scientific literacy questions must enable students to process the information in the questions, (4) Questions can be made into several variations of question form (multiple choice, essay, fill-in-the-blank), (5) Questions must include the application context (Teresia, 2021).

Based on data from the evaluation results of the Program for International Student Assessment (PISA) in 2018, Indonesia is one of the countries that participates in PISA. From the results of the 2018 PISA survey in the reading ability category, Indonesia was ranked 74th out of 79 countries, while for the assessment of mathematics ability and science ability, Indonesia was ranked 73rd and 71st out of 79 PISA participating countries (Hewi & Shaleh, 2020). Based on the results of the PISA survey, it shows that the scientific literacy abilities of Indonesian students are still relatively low.

Based on the results of interviews with teachers at three senior high schools in Bengkulu City, it is known that physics learning carried out in schools generally uses teaching materials in the form of teacher and student textbooks. The use of media, especially electronic learning media such as electronic modules, has not been used optimally, even though in practice the use of electronic devices such as smartphones is permitted if used as a tool to support learning in schools. Apart from that, the learning model used in schools is good, but the use of the problem-solving-based model has not been used optimally because implementing the problem-solving-based model requires thorough preparation and requires more time in preparation, resulting in the PBL model being used not being optimal. Lack of interest in reading also makes students lack of understanding (facts, principles and concepts) in learning. Students tend to memorize and don't really understand concepts so students tend to have difficulty answering questions related to everyday life. Students still have difficulty applying scientific concepts in everyday life.

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Based on the study of these problems, researchers developed a Problem Based Learning-oriented Physics E-module to increase the scientific literacy of high school students.

METHODS

Research carried out uses research and development methods or what is usually called Research and Development (R&D) with the aim of developing a new product or improving a previously existing product. Research and development methods can be interpreted as a scientific way to research, design, produce and test the validity of the products produced (Sugiyono, 2017). The model used in this research is the ADDIE (Analysis, Design, Development, Implementation, Evaluation) (Branch). However, this research was limited to the Development stage by testing the validity and perceptions of students due to time constraints. This research was conducted at three senior high schools in Bengkulu City. This development research has qualitative data obtained based on observations and interviews, while the quantitative data from this research was obtained from the results of questionnaires given to validators and student perception questionnaires. The research instruments used in this research are: 1) material expert validation sheet, 2) media expert validation sheet, 3) learning design expert validation sheet, and 4) student perception questionnaire. Meanwhile, data analysis was obtained through an assessment of the development product which aims to determine and assess the suitability of the product that has been developed as a teaching material. Quantitative data was obtained through validation questionnaires by 3 physics teachers as material expert validators, 3 physics lecturers as media expert validators and learning design experts, as well as student perceptions. The suitability between the indicator items and the E-Module product is assessed using a 4 Likert scale.

To calculate the average score for each aspect assessed, the following equation is used (Kimianti & Prasetyo, 2019) :

$$\bar{x} = \frac{\Sigma x}{N}$$

Annotation :
$\bar{x}$: average score of assessment by members
Σx : total score obtained
N : total score amount

After the score data for assessing the suitability of teaching materials is calculated, the average is then converted into a percentage. The percentage yield formula can be calculated using the following formula (Wijayanti et al., 2022) :

$$P = \frac{\Sigma x}{\Sigma x_i} x\ 100\ \%$$

Annotation :
P : The percentage of each aspect
Σx : The total sum of each aspect's rating
Σxi : The sum total of the ideal value of each aspect

After knowing the average score results in each aspect and their percentages, then the percentage results obtained are grouped into feasibility criteria which state that the product being developed is suitable for use as shown in Table 1.

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Table 1. Eligibility evaluation criteria

Percentage of Achievement	**Interpretation**
76 - 100 %	Very Feasible
56 - 75 %	Feasible
40 - 55 %	Enough
0 - 39 %	Not feasible

(Arikunto, 2016)

The percentage of students' perceptions is interpreted into the following criteria or categories (Putri et al., 2020) :

Table 2. Criteria for assessment of student perceptions

Score Range	**Criteria**
81,25 ≤ skor ≤ 100	Very good
62,5 ≤ skor ≤ 81,25	Good
43,75 ≤ skor ≤ 62,5	Not good
25 ≤ skor ≤ 43,75	Not very good

RESULTS AND DISCUSSION

Analysis

In this development research, the first stage carried out was the analysis stage, namely needs analysis by conducting observations and interviews with teachers at three senior high schools in Bengkulu City regarding the curriculum used in schools, learning resources used, learning processes in class, learning methods applied, and learning media used in schools. After the analysis was carried out, the results showed that the curriculum used in the learning process at school currently is the 2013 curriculum. In the learning carried out, the teaching materials that are often used are still print media, namely teacher books and student books. Due to limited learning time at school, the material to be taught has not been fully conveyed by the teacher, while the demands on the material being taught are quite large, making students less likely to understand the material as a whole. The use of problem-solving-based models has not been used optimally because implementing problem-solving-based models requires thorough preparation and requires more time in preparation, resulting in the PBL model being used not being optimal. Apart from that, a lack of interest in reading also makes students lack of understanding (facts, principles and concepts) in learning. Thus, the development of problem-based learning-oriented physics e-modules to increase students' scientific literacy is still very necessary.

Kimianti & Prasetyo (2019) in his research entitled Development of a Science E-Module Based on Problem Based Learning to Improve Students' Scientific Literacy, concluded that a science e-module based on problem-based learning which was created as a practical, flexible and independent online operating teaching material can facilitate scientific literacy skills of students in solving problems in everyday life and to meet global challenges. Furthermore Lendeon & Poluakan (2022) in his research explained that the application of the Problem Based Learning model can improve the scientific literacy skills of class XI students at SMAN 1 Lembah Melintang, West Pasaman Regency in the affective, cognitive and psychomotor domains. After carrying out the analysis stage, the researchers developed a Problem Based Learning-oriented physics e-module to increase the scientific literacy of high school students.

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Design

The second stage carried out is the design stage, namely designing the format of the e-module you want to develop. The material used is static fluid material. Kurniawan (2019) states that Static fluids are material in physics learning for class XI high school. The characteristics of static fluids are learning material that students can observe directly. Static fluid material has a lot to do with everyday life, so static fluid material is important for students to understand. Static fluid learning is considered less successful if it is not supported by learning facilities. Based on the syllabus, the basic competencies in static fluid material are: 3.3) Applying the laws of static fluids in everyday life, 4.3) Designing and carrying out experiments that utilize the properties of static fluids, along with a presentation of the experimental results and their use. The initial design used a physics learning module by the Ministry of Education and Culture which can be seen in Figure 1.

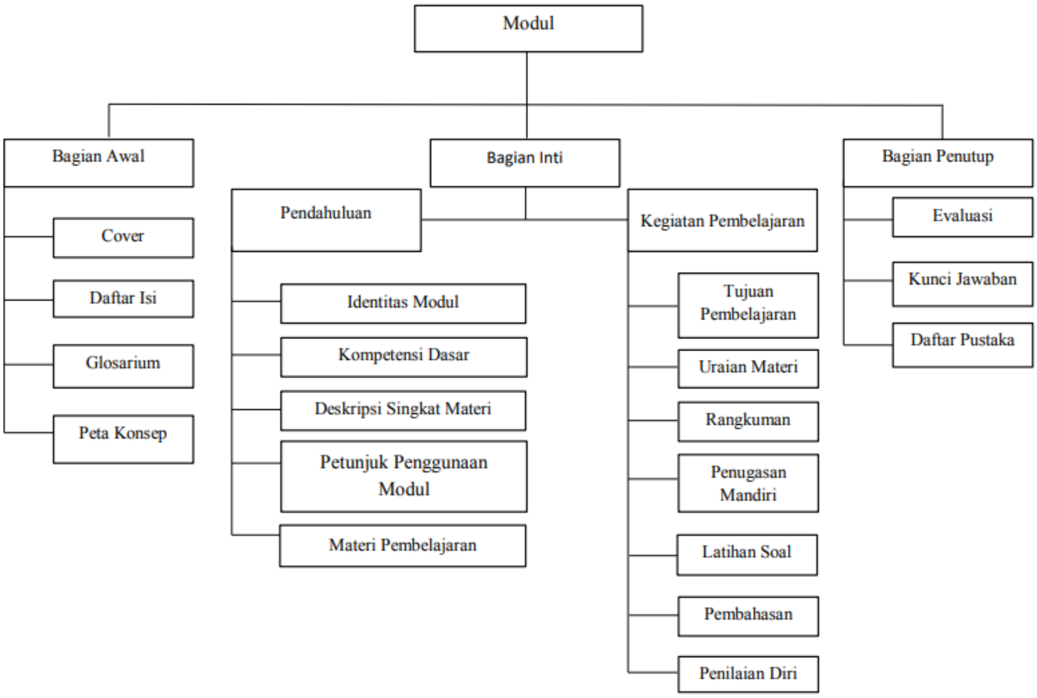

Figure 1. Initial design (In Bahasa)

The initial design of the module had several weaknesses, namely that indicators of competency achievement were not yet available, the material presented was still incomplete, the use of images in the module was still lacking, especially in the questions that required illustrative images, Student Worksheets (LKPD) were not yet available. There are assessment guidelines available in the module, and there are no Problem Based Learning learning steps.

Based on this, the researchers developed a design for physics teaching materials through E-Modules using Problem Based Learning learning steps which can be seen as in Figure 2.

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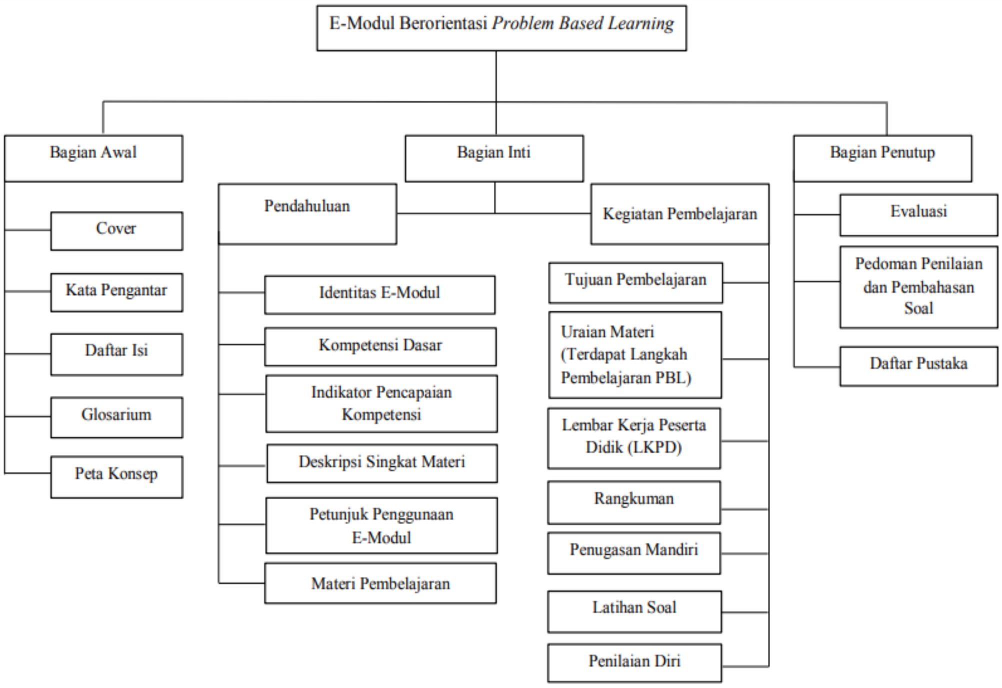

Figure 2. Developed e-module design (in Bahasa)

The e-module is designed according to the specified format and then the learning steps are developed using the Problem Based Learning (PBL) learning model. The learning activities in the e-module use Problem Based Learning learning steps which are characterized by the let's understand activity which contains the activity of observing a video and being given a problem. This activity describes the students' orientation steps towards the problem. Furthermore, through the let's learn activity, students are given an explanation of the material which is an illustration of the steps in organizing students to learn. In the let's do activity, students are invited to design and carry out experiments which are an illustration of the steps to guide individual and group investigations. After that, in the let's show activity, students are asked to create experimental data which is an illustration of the steps to develop and present the results of their work. Next, in the let's develop your knowledge activity, students are asked to draw conclusions from the results obtained, where this activity is an illustration of the steps to analyze and evaluate the problem solving process. The appearance of the Problem Based Learning steps contained in the E-Module can be seen as in Figure 3.

Development

The third stage carried out is the development stage. This stage is the stage to complete the preparation of the contents of the product. The product was first created using Microsoft Word to create text and insert images, then converted into PDF. In order to display animations from video shows, researchers use the Flip PDF Professional application by importing the module files that have been created into the Flip PDF Professional application.

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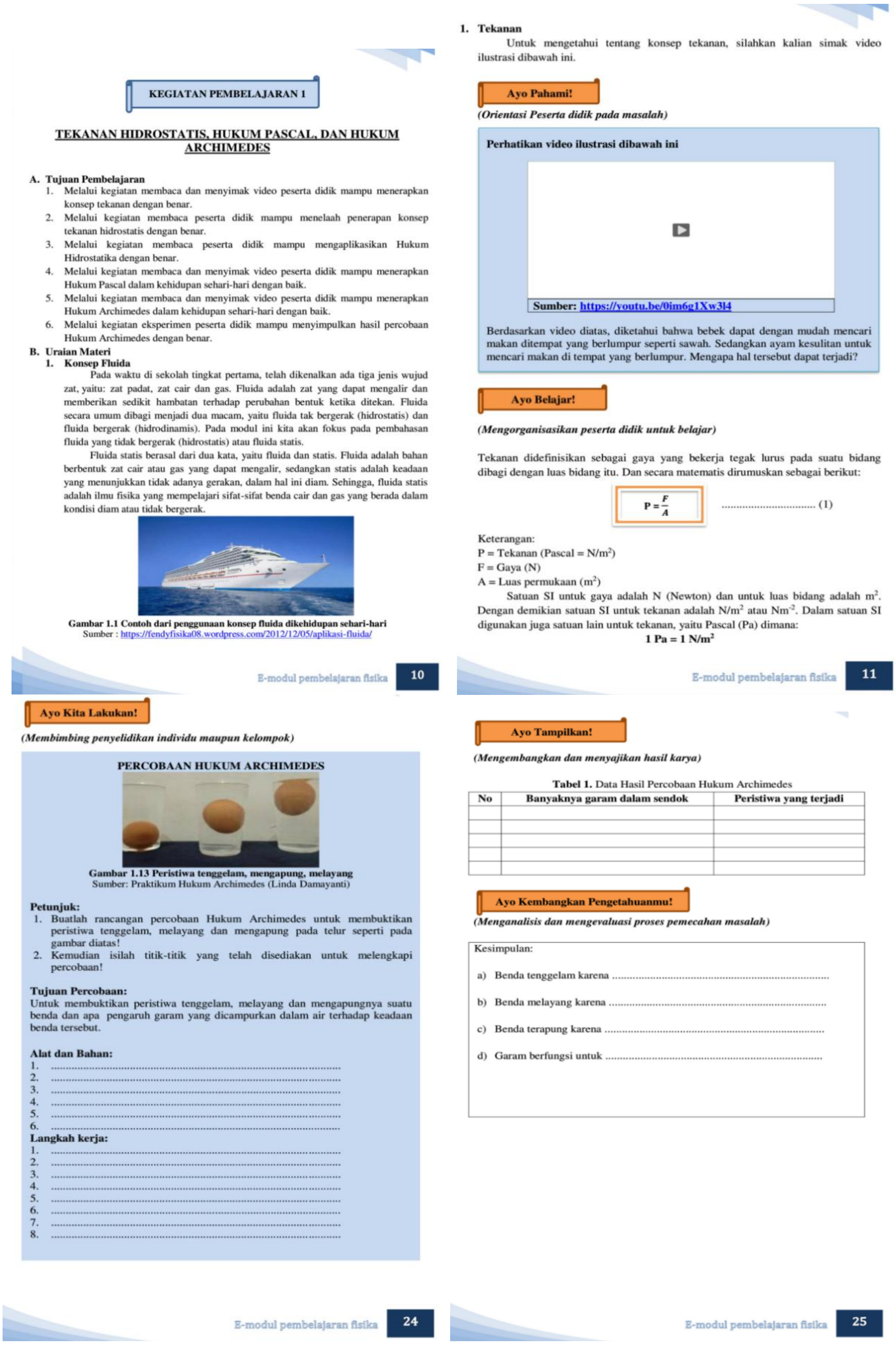
KEGIATAN PEMBELAJARAN 1

TEKANAN HIDROSTATIS, HUKUM PASCAL, DAN HUKUM ARCHIMEDES

A. Tujuan Pembelajaran
1. Melalui kegiatan membaca dan menyimak video peserta didik mampu menerapkan konsep tekanan dengan benar.
2. Melalui kegiatan membaca peserta didik mampu menelaah penerapan konsep tekanan hidrostatis dengan benar.
3. Melalui kegiatan membaca peserta didik mampu mengaplikasikan Hukum Hidrostatika dengan benar.
4. Melalui kegiatan membaca dan menyimak video peserta didik mampu menerapkan Hukum Pascal dalam kehidupan sehari-hari dengan baik.
5. Melalui kegiatan membaca dan menyimak video peserta didik mampu menerapkan Hukum Archimedes dalam kehidupan sehari-hari dengan baik.
6. Melalui kegiatan eksperimen peserta didik mampu menyimpulkan hasil percobaan Hukum Archimedes dengan benar.

B. Uraian Materi
1. Konsep Fluida
Pada waktu di sekolah tingkat pertama, telah dikenalkan ada tiga jenis wujud zat, yaitu: zat padat, zat cair dan gas. Fluida adalah zat yang dapat mengalir dan memberikan sedikit hambatan terhadap perubahan bentuk ketika ditekan. Fluida secara umum dibagi menjadi dua macam, yaitu fluida tak bergerak (hidrostatis) dan fluida bergerak (hidrodinamis). Pada modul ini kita akan fokus pada pembahasan fluida yang tidak bergerak (hidrostatis) atau fluida statis.
Fluida statis berasal dari dua kata, yaitu fluida dan statis. Fluida adalah bahan berbentuk zat cair atau gas yang dapat mengalir, sedangkan statis adalah keadaan yang menunjukkan tidak adanya gerakan, dalam hal ini diam. Sehingga, fluida statis adalah ilmu fisika yang mempelajari sifat-sifat benda cair dan gas yang berada dalam kondisi diam atau tidak bergerak.

Gambar 1.1 Contoh dari penggunaan konsep fluida dikehidupan sehari-hari
Sumber : https://fendyfisika08.wordpress.com/2012/12/05/aplikasi-fluida/

E-modul pembelajaran fisika 10

1. Tekanan
Untuk mengetahui tentang konsep tekanan, silahkan kalian simak video ilustrasi dibawah ini.

Ayo Pahami!
(Orientasi Peserta didik pada masalah)

Perhatikan video ilustrasi dibawah ini

Sumber: https://youtu.be/0im6g1Xw3l4

Berdasarkan video diatas, diketahui bahwa bebek dapat dengan mudah mencari makan ditempat yang berlumpur seperti sawah. Sedangkan ayam kesulitan untuk mencari makan di tempat yang berlumpur. Mengapa hal tersebut dapat terjadi?

Ayo Belajar!
(Mengorganisasikan peserta didik untuk belajar)

Tekanan didefinisikan sebagai gaya yang bekerja tegak lurus pada suatu bidang dibagi dengan luas bidang itu. Dan secara matematis dirumuskan sebagai berikut:

$$P = \frac{F}{A} \quad \text{.................. (1)}$$

Keterangan:
P = Tekanan (Pascal = N/m^2)
F = Gaya (N)
A = Luas permukaan (m^2)
Satuan SI untuk gaya adalah N (Newton) dan untuk luas bidang adalah m^2. Dengan demikian satuan SI untuk tekanan adalah N/m^2 atau Nm^{-2}. Dalam satuan SI digunakan juga satuan lain untuk tekanan, yaitu Pascal (Pa) dimana:
$1 \text{ Pa} = 1 \text{ N/m}^2$

E-modul pembelajaran fisika 11

Ayo Kita Lakukan!
(Membimbing penyelidikan individu maupun kelompok)

PERCOBAAN HUKUM ARCHIMEDES

Gambar 1.13 Peristiwa tenggelam, mengapung, melayang
Sumber: Praktikum Hukum Archimedes (Linda Damayanti)

Petunjuk:
1. Buatlah rancangan percobaan Hukum Archimedes untuk membuktikan peristiwa tenggelam, melayang, dan mengapung pada telur seperti pada gambar diatas!
2. Kemudian isilah titik-titik yang telah disediakan untuk melengkapi percobaan!

Tujuan Percobaan:
Untuk membuktikan peristiwa tenggelam, melayang dan mengapungnya suatu benda dan apa pengaruh garam yang dicampurkan dalam air terhadap keadaan benda tersebut.

Alat dan Bahan:
1. ....
2. ....
3. ....
4. ....
5. ....
6. ....

Langkah kerja:
1. ....
2. ....
3. ....
4. ....
5. ....
6. ....
7. ....
8. ....

E-modul pembelajaran fisika 24

Ayo Tampilkan!
(Mengembangkan dan menyajikan hasil karya)

Tabel 1. Data Hasil Percobaan Hukum Archimedes

No	Banyaknya garam dalam sendok	Peristiwa yang terjadi

Ayo Kembangkan Pengetahuanmu!
(Menganalisis dan mengevaluasi proses pemecahan masalah)

Kesimpulan:
a) Benda tenggelam karena ....
b) Benda melayang karena ....
c) Benda terapung karena ....
d) Garam berfungsi untuk ....

E-modul pembelajaran fisika 25

Figure 3. Display of problem based learning steps in e-module (in Bahasa)

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In the scientific literacy aspect, the researcher adjusted the scientific literacy indicators to be achieved into the problem based learning (PBL) learning steps contained in the e-module that has been developed. The scientific literacy indicators can be seen in Table 3.

Table 3. Scientific literacy indicators

Aspects of Scientific Literacy	Indicators	Description
Knowledge	Content Knowledge	Have an understanding related to context
	Procedural Knowledge	Conduct investigations to obtain evidence
	Epistemic Knowledge	Ask students to identify whether the conclusion is justified by the data or partial evidence
Competence	Ability to explain scientific phenomena	Requires students to remember content knowledge that is appropriate in certain conditions
	Evaluate and design Scientific Research	Evaluate scientific reports under investigation
	Interpreting scientific data and evidence	Draw conclusions based on evidence
Attitude	Interest in science and technology	Assess scientific approaches and attitudes towards environmental awareness

(OECD 2015) in (Siti Fathonah, 2020).

In the product being developed, there are also questions provided which have the characteristics of questions for assessing scientific literacy. The assessment of scientific literacy in the form of questions has the characteristics of questions, namely: (1) Questions that contain broader concepts because they are not only related to concepts in the curriculum, (2) Questions must contain information or data in various form of presentation to be processed by students who will answer it, (3) Scientific literacy questions must enable students to process the information in the questions, (4) Questions can be made in several variations of question form (multiple choice, essay, fill-in-the-blank), (5) Questions must cover the context of the application (Wahyuni Teresia, 2021)

At this stage the product that has been developed will be validated by material experts, media experts and learning design experts to determine whether the product that has been developed is suitable for use or not, then revisions will be made according to the validator's suggestions. This e-module can be used online by accessing the page: https://online.flipbuilder.com/imjgr/ahfy/ which can be accessed via smartphone, laptop or computer.

The Results of Experts Validation

The table of validation results that have been carried out is as follows.

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The table of material expert validation results can be seen in Table 4.

Table 4. Result validation of material expert

Assessed Aspects	Percentage of Achievement	Description
Content qualification	91,58%	Very Feasible
Presentation qualification	100%	Very Feasible
Language qualification	98,3%	Very Feasible
PBL assessment	100%	Very Feasible
Average overall aspect	**97,47%**	**Very Feasible**

Table 4 shows the results of validation with material experts. Material expert validation was carried out by 3 physics teachers. The aspects assessed from material expert validation are aspects of content suitability, presentation suitability aspects, language suitability, PBL assessment aspects. In the content feasibility aspect, the achievement percentage was 91.58% in the very feasible category. This indicates that the material contained in the e-module is in accordance with the curriculum and basic competencies used. In the presentation feasibility aspect, a percentage achievement of 100% was obtained. This indicates that the presentation of the e-module created has helped students to understand the material and contains all the completeness of the presentation. In the language feasibility aspect, the achievement percentage was 98.3% in the very appropriate category. These results mean that the language used in the e-module is easy to understand and complies with linguistic rules. In the PBL assessment aspect, the achievement percentage was 100% in the very feasible category. These results show that the e-module created contains the steps of the problem based learning model which consists of 5 steps, namely orienting students to the problem, organizing students to learn, guiding individual/group investigations, developing and presenting the results of their work. , analyze and evaluate the problem solving process. The average of all aspects of the material expert validation results obtained was an achievement percentage of 97.47% with a very feasible category. Based on this, it can be concluded that the physics e-module being developed is included in the very feasible category based on the assessment of the material expert validator. In line with that (Hudha et al., 2017) in his research explained that the feasibility of developing a physics module based on Problem Based Learning was tested by looking at the appropriateness of the content, presentation and language. The table of media expert validation results can be seen in Table 5.

Table 5 shows the results of validation with media experts. Media expert validation was carried out by 3 physics lecturers. The aspects assessed from media expert validation are e-module size, cover design, e-module content design. It can be seen that the e-module size obtained an achievement percentage of 100% with a very feasible category. This shows that the

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size of the e-module made is in accordance with ISO standards. In the cover design, the achievement percentage was 85.58% in the very feasible category. This indicates that the cover of the e-module is good, the letters used are attractive and easy to read and the illustrations on the cover depict the teaching material contained in the e-module. In the e-module content design, the achievement percentage was 92.25% in the very feasible category. This shows that the appearance of the e-module content is good in terms of text layout, illustrations and image captions, included videos, selection of size and type of letters (fonts) used, as well as selection of colors and backgrounds used.

Table 5. Result validation of media expert

Assessed Aspects	Percentage of Achievement	Description
E-module size	100%	Very Feasible
Cover design	85,58%	Very Feasible
E-module content design	92,25%	Very Feasible
Average of all aspects	**92,61%**	**Very Feasible**

On average, all aspects of the media expert validation results obtained an achievement percentage of 92.61% in the very feasible category. Based on this, it can be concluded that the physics e-module that has been developed is included in the very feasible category based on the assessment of media expert validators. In line with that Serevina et al., (2018) in their research explained that aspects of media suitability including suitability of content, appearance design (cover design, typeface, text and image layout and combination) are considered suitable for use as teaching materials independently. The table of validation results of learning design experts can be seen in Table 6.

Table 6. Learning design expert validation results

Assessed Aspects	Percentage of Achievement	Description
Learning objectives	97,91%	Very Feasible
Method	91,66%	Very Feasible
Evaluation	100%	Very Feasible
Average of all aspects	**96,52%**	**Very Feasible**

Table 6 shows the validation results with learning design experts. Validation of learning design experts was carried out by 3 physics lecturers. The aspects assessed from the validation results of learning design experts are learning objectives, methods, evaluation. In the aspect of learning objectives, the achievement percentage was 97.91% in the very feasible category. This shows that conformity has been achieved between the learning objectives and indicators as well as the suitability of the material with the learning objectives. In the method aspect, the achievement

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percentage was 91.66% with a very feasible category, which shows that the learning design contained in the e-module is appropriate. In the evaluation aspect, the achievement percentage was obtained at 100% with a very feasible category. These results show that assessment is available in the e-module, the questions contained in the e-module are relevant to the learning objectives, and there is clarity in the assessment of learning outcomes. The average percentage for all aspects of the learning design assessment obtained an average of 96.52% with a very feasible category. Based on this, it can be concluded that the e-module developed is included in the very feasible category based on the assessment of learning design experts.

Table 7. Comments and suggestions from validators

No	Validator	Comments and Recommendation	Revision
1	Material Expert	Example questions should use images as stimuli	Adding pictures to some examples of questions that really need the addition of pictures
		The image is made clearer	Review the pictures found in the e-module and clarify the pictures
2	Media Expert	Use a larger resolution image so that the image is not broken	Improved image resolution on e-module
		Move the discussion of practice and evaluation to the back so that students do not immediately see the answers when working on the questions	Move all training discussions and evaluations to the back of the e-module
		Consistent use of formulas and symbols	Review the use of formulas and symbols
		The writing on the back cover has been made clearer and more attractive	Changed the font used on the back cover
		The front cover has been made more attractive	Replaced the front cover with a more attractive one
		Align the front cover and back cover	Align the front and back covers
3	Learning Design Specialist	Adjust questions to suit learning objectives	The questions have been adjusted to suit the learning objectives

The e-module product that has been developed obtained an average of all aspects in the very worthy category in terms of validation assessments by material experts, media experts and learning design experts. Therefore, due to the factors mentioned above, the e-module product that has been developed is suitable for use as a support for physics learning in the classroom learning process. In line with this, Lyani and Wahyuni (2021) in their research explained that the development of teaching materials in the form of e-modules using development design steps is an alternative effort aimed at making it easier for students to learn physics and

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for teachers it can be a reference in carrying out the learning process.

At this stage the researcher also received comments and suggestions from validators who had assessed the product that had been developed. The comments and suggestions given can be seen from Table 7.

Perception of Students

After validation, the e-module was categorized as very feasible based on the results of validation by material experts, media experts and learning design experts. Next, a trial was carried out on the e-module that had been developed to collect student perception data. The process of collecting data on student perceptions was taken by asking students to read and provide responses to the e-module using a questionnaire developed to see students' perceptions of the product being developed by looking at 3 indicators, including: interest, material and language. Based on the questionnaire that was filled out by the students, the results of the students' perceptions were obtained as shown in Table 8.

Table 8. Results of Perception of Students

Assessed Aspects	Percentage of Achievement	Description
Interest	92,27%	Very Good
Material	92,15%	Very Good
Language	98,28%	Very Good
Overall Aspect Average	**94,23%**	**Very Good**

Table 8 shows the results of student perceptions with an overall average of 94.23% which is included in the very good category. As for the response, this proves that the problem-based learning-oriented physics e-module to improve students' scientific literacy has been developed and is suitable for use in the physics learning process in the classroom.

CONCLUSION AND RECOMMENDATION

Based on the results of the research that has been carried out, it is concluded that the development of a Problem Based Learning-oriented Physics E-Module to Improve the Scientific Literacy of High School Students which has been produced through the analysis, design and development stages has been declared suitable for use in supporting the physics learning process in schools. This is proven by the validation results carried out by material expert validators who obtained an overall aspect average of 97.47%, media experts obtained an overall aspect average of 92.61%, and learning design experts obtained an overall aspect average of 96.52% which included in the very decent category and the results of student perceptions obtained an overall average of 94.23% which is included in the very good category.

The advice that researchers can give to future researchers is that further research needs to be carried out to determine the level of effectiveness of the products developed in physics learning.

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