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Development of Physics E-modules Based on Problem Based Learning Model Assisted by Heyzine Flipbook to Improve Problem Solving Ability

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Abstract

This study aims to validate the feasibility of physics e-modules based on Problem Based Learning (PBL) model assisted by heyzine flipbook, improve students' problem solving skills after using physics e-modules based on PBL model assisted by heyzine flipbook, and describe students' responses to physics e-modules based on PBL model assisted by heyzine flipbook. The research was conducted in class XI of SMA Negeri 6 Bengkulu City in the 2024/2025 academic year. With the R&D method and ADDIE model. The results of the research from the product validation test stage with a score of 86% (very feasible category) to be used in the physics learning process. The results of the N-gain value through the prettest and posttest tests obtained a score of 0.75 (high category) so that the physics e-module can improve students' problem solving skills. The results of the student response questionnaire obtained a score of 81% (very good category). It can be concluded that the physics e-module based on the PBL model assisted by heyzine flipbook gets a positive response from students.

Keywords: *E-module, problem based learning (PBL), problem-solving skills.*

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1. INTRODUCTION

Physics is a science in which students learn about the nature and fe.nome.na of nature or natural gejala and all the interactions that occur. The teaching of physics encourages students to think critically and creatively and is important in developing the character of all people, especially cognitive, affective, and psychomotor character based on a high attitude of knowledge in understanding a natural phenomenon (Rasyid Anita,2024). Students find it difficult to understand some abstract concepts. The lack of student interest in physics is because they think there are many formulas that must be memorized. Based on the results conducted by (Riyan & Fatimah, 2022), indicates that more than 60% of students experience a decrease in motivation in learning physics, which is characterized by a lack of active participation and low learning outcomes, especially in material that is abstract and less contextual in everyday life.

Teachers need to provide various facilities and create a conducive learning environment so that the learning process can take place in an effective and efficient manner (Amiruddin et al.,2024). The physics teaching process will be carried out well if the teacher teaches the physics materi by choosing the right teaching strategy and mode. l of teaching that is appropriate and can provide direct experience to students, because teaching methods can help teachers in the teaching process. This is in accordance with the opinion of (Chandra et al., 2021).

Based on the results of observation on physics teaching in class XI of SMAN 6 Kota Bengkulu, it shows that there are still many students who have difficulty in understanding physics mathematics. On the other hand, the physics teaching activities that have not been effective in improving students' problem solving skills. One of the problem solving skills can be improved by the presence of interesting teaching materials in accordance with the BSKAP (Board of Standards,

Curriculum, and Education Standards) as a physics teaching method. According to BSKAP, quality learning media/textbooks must meet four elements of eligibility, namely the aspect of content eligibility, the aspect of presentation, the aspect of language, and the aspect of media/graphics. The four elements of eligibility are described in the form of fairly detailed indicators, so that anyone (both textbook/media assessors, teachers, and students) can apply them. Based on the information obtained through interviews with physics teachers, it was explained that the level of students' problem solving ability in physics teaching was still very low, namely less than 50% and the score was still below the average KKM 80, so there was a need for improvement. The problem of low problem solving ability can be found in indicators including understanding the problem and solving the problem.

The learning model that is suitable for overcoming the problem is the Problem Based Learning (PBL). PBL model is a model of learning that trains students to work on otentic problems that are student-centered (Puspitasari A.D, 2019) with a view to developing self-directed knowledge, developing thinking and problem-solving skills, and developing self-reliance and self-confidence. PBL can also be defined as a mode of teaching that uses problems as a focus to enhance problem-solving skills (Hidayati &Wagiran, 2020). According to Polya in (Tawary et al., 2021) that problem solving skills involve four main stages, each with specific indicators to evaluate students' skills including: 1) understand the problem, 2) plan the problem solving strategy, 3) solve the problem solving strategy, 4) check the answer that has been reached.

One of the interactive teaching tools is electronic module or e-module which is a teaching tool created and accessed in a systematic way based on a specific curriculum that is displayed using a computer or smartphone. E-modules have an important role in the teaching process which can help teachers to explain the teaching materi. The advantage of e-modules compared to other courses is that they are interactive. E-modules in digital format can be read on a laptop or computer. E-modules are also equipped with teaching video, animation, images, and audio facilities. E-modules can be used as one of the best alternatives to improve the understanding of learners, so that it can also improve the problem-solving ability of the learners (Sari et al., 2021). The utilization of e-modules as a student learning resource can facilitate learning for both teachers and students because of the use of smartphones that greatly support the teaching process. Flipbook is one of the e-modules used by teachers and students. The e-module developed using the PBL model uses heyzine flipbook software. Heyzine flipbook is an application that is useful for creating flipbook-based e-modules. A web-based program called Heyzine Flipbook can convert PDF files into books, brochures, catalogs, magazines, digital brochures and can be accessed for free or paid without the need to download the application(Ashari & Puspasari, 2024).

Pedagogically, the use of Heyzine Flipbook is in line with the PBL approach, which places students at the center of learning and encourages active involvement in solving real-world problems. According to Barrows (1986), PBL emphasizes the learning process through investigation of open-ended problems, exploration of information, and reflection on the solutions found. Heyzine Flipbook-based e-modules provide high learning freedom, allowing students to access materials anytime and anywhere, and adjust their own learning pace. This is very relevant to the characteristics of PBL which emphasizes flexibility and independent learning.

Previous, Gita et.al (2022) has conducted a research entitled development of PBL-based physics e-modules to improve students' problem solving skills. In this study, it discusses the learning media for physics e-modules based on the PBL model to improve students' problem solving skills with the help of flip pdf comporate with the topic of balance and rotational dynamics. Based on this previous research, it shows that the e-modules developed are feasible and effective for improving students' problem solving skills.

Based on this description, the objectives of this study are: (1) Determine the feasibility of physics e-modules based on PBL model assisted by heyzine flipbook. (2) Improve students' problem solving skills after using physics e-modules based on PBL model assisted by heyzine flipbook. (3) Describe students' responses to physics e-modules based on PBL model assisted by heyzine flipbook.

2. METHODS

This research uses the Research and Development (R&D) development method and the ADDIE approach model which includes Analysis, Design, Development, Implementation, and Evaluation.

(Branch, 2009). The participants in this study consisted of 2 Physics Education lecturers, 1 physics teacher, and class XI-C students totaling 35 students who were used as research subjects. This research was conducted in the odd semester of the 2024/2025 school year.

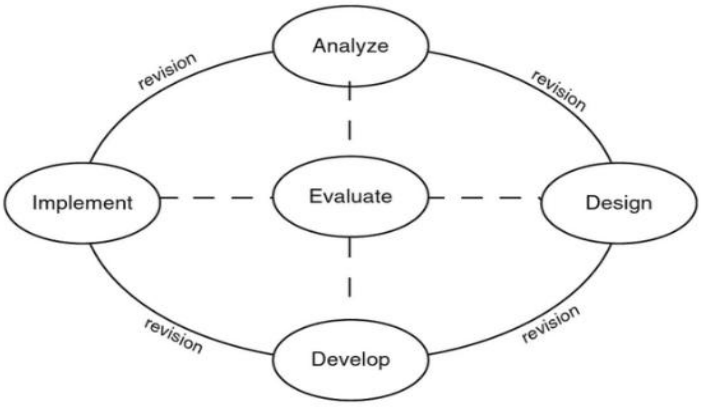

Figure 1. ADDIE Development Model

(Branch,2009)

The validation sheet is used to evaluate the feasibility of the developed e-module. The validation sheet aims to use qualitative and quantitative analysis by calculating the percentage of questionnaire scores by comparing the total score obtained and the maximum score. Then converted into a feasibility category (Damayanti et al., 2018). Quantitative data is obtained from the assessment score given by the validator, then the data is analyzed by calculating the percentage of the score with the formula (1):

$$\text{Score Percentage} = \frac{total\ obtained}{maximum\ score} \times 100\% \quad (1)$$

(Harnisa et al., 2024).

Furthermore, the data from the scores were interpreted with qualitative categories referring to **Table 1.**

Table 1. E-module Feasibility Category

Interval	Category
0% ≤ score ≤ 25%	Very Unfeasible
25% ≤ score≤ 50%	Not Feasible
50% ≤ score ≤ 75%	Worth
75% ≤ score ≤ 100%	Very Feasible

The analysis of problem solving ability used the pre-test and posttest as the measurement instrument in this study. Pretest and posttest scores were analyzed using Normalized gain average or N-gain. The results of the N-gain score were used to measure the level of students' problem solving ability. N-gain was calculated using equation (2):

$$\langle g \rangle \equiv \frac{\%\langle G \rangle}{\%\langle G \rangle_{max}} = \frac{\%\langle S_f \rangle - \%\langle S_i \rangle}{100 - \%\langle S_i \rangle} \quad (2)$$

(Hake, 1998)

Then converted into categories that refer to **Table 2.**

Table 2. N-gain Level Category

Interval	Category
g $\geq$ 0,7	High
0,7 > $g \geq$ 0,3	Medium
$g <$ 0,3	Low

(Hake, 1998).

Response analysis was conducted by distributing evaluation questionnaire sheets to students consisting of assessments using a Likert scale. The purpose of this questionnaire was to determine the extent to which students gave assessments and responses to the developed e-module, both in terms of content, appearance, ease of use, and relevance to the PBL model. The results of this analysis were concluded quantitatively and qualitatively. The student response questionnaire sheet aims to determine students' responses to the physics e-module created. This sheet was conducted using quantitative and qualitative analysis by calculating the percentage of the questionnaire score by comparing the total score obtained and the maximum score. The data from this response questionnaire was analyzed using the equation:

$$\%\ score\ interpretation\ = \frac{\Sigma\ score\ obtained}{\Sigma\ maximum\ score} \times 100\% \qquad (3)$$

Furthermore, it is converted into categories that refer to **Table 3**.

Table 3. Category of Student Response

Interval	Category
0% ≤ score ≤ 25%	Very Less
25% ≤ score ≤ 50%	Not Good
50% ≤ score ≤ 75%	Good
75% ≤ score ≤ 100%	Very Good

(Melianti et.al.,2020)

3. RESULTS AND DISCUSSION

Result

The results of research on the development of physics e-modules based on the problem-based learning model assisted by heyzine flipbook include the stages of analysis, design, development, implementation, and evaluation.

Analyze

The analyze stage is the pre-planning stage of developing new products by identifying products that are in accordance with the target learners, learning objectives, and identifying learning. At the analysis stage, field studies and literature studies were conducted. The results of the field study were conducted by interviewing physics teachers at the school which showed that: (1) the level of student interest in physics lessons is still relatively low; (2) during the learning process, teachers still use teaching materials in printed form such as books and student worksheets (LKS); (3) The use of learning media is still limited and the learning system is still teacher-focused or with the lecture method. Therefore, the level of students' problem solving ability in solving a physics problem is still low as seen in the lack of student initiative in understanding and learning physics material. One of the materials identified as difficult to understand by students is newton's law material about motion so that less than 50% of 35 students (27 students) get scores below the KKM standard, which is set at a score of 80; (4) Teachers and 80% of students say there is a need for learning media development that can help in the learning process; (5) Based on school policy, students are allowed to bring and use cellphones and laptops if they have received permission from their subject teacher. Based on literature studies, the findings are consistent with related research, such as research by (Senja et al., 2024) which concluded that the development of physics e-modules based on the PBL model is a useful alternative as an addition to student learning.

Design

In the design stage, the e-module structure is compiled, consisting of a cover page, module position map, preface, table of contents, concept map, introduction section which includes material description, prerequisite material, instructions for using e-modules for teachers and students, e-module display, and learning competencies, then the learning section where each learning activity contains objectives, material description, summary, practice questions and worksheets. After that is the evaluation section and bibliography. Product creation as the basis for making e-modules and digitizing with conversion in the Canva application. The result of this design stage is the initial product. At this stage, the learning media design is made, which is shown in **Figure 2**.

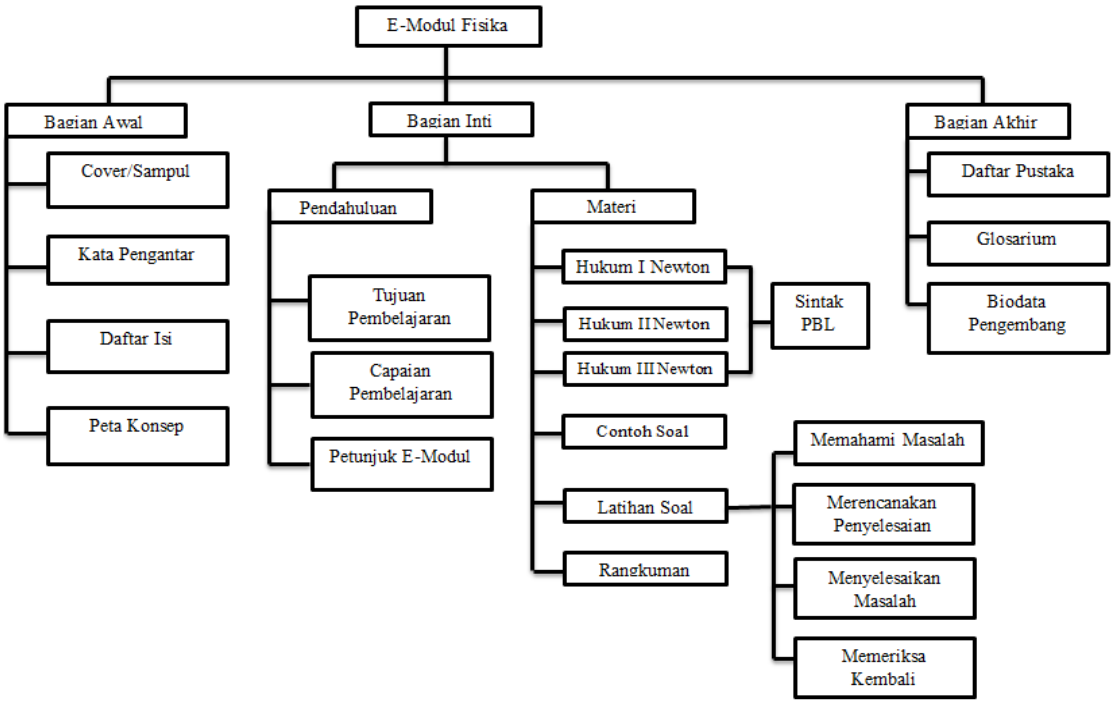

Figure 2. Design of physics e-module design

Figure 3. Front cover page design

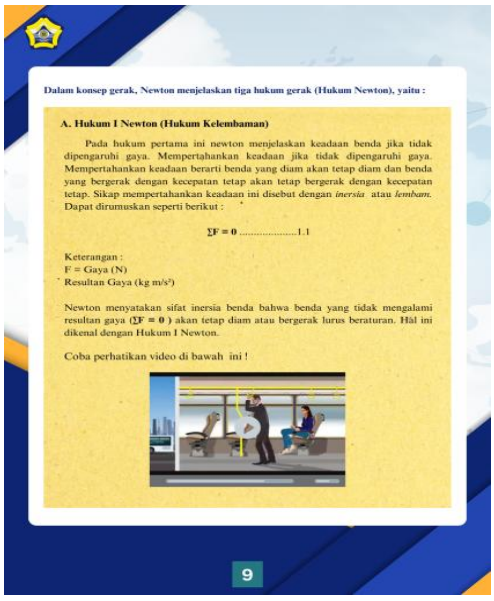

Figure 4. Learning activity design

Figure 5. Material page with steps of PBL model

Development

This stage is the development stage to produce products in the form of interactive learning media. Making a design at the e-module cover design stage using Canva with the overall design of the e-module developed using the Heyzine Flipbook assisted application. Then, this learning media was validated by three validators. Three validators, consisting of two physics education lecturers and one physics teacher, will conduct validation. The results of the e-module product validation process are presented in **Table 4**.

Table 4. Validation of The Product

Validator	Score Obtained	Maximum Score	Average Percentage
1	77	88	88%
2	69	88	78%
3	80	88	91%
	Total Category		**86% Very Feasible**

Based on the results of the validation assessment of the three validators, it is stated that the Based on the results of the validation assessment from the three validators, it states that the learning media in the form of a physics e-module that was developed obtained an average score of 86% with the category of "very feasible", with validation of several aspects, namely, aspects of material/content, presentation/design, language aspects, media and aspects of problem-solving abilities. So it can be concluded that the physics e-module based on the PBL model, according to experts, is very feasible to be tested in schools. However, in the expert validation test there were several suggestions for improvement which can be seen in **Table 5** :

Table 5. Product Revision According to Experts

Aspect	Category
Content Aspect	Fix the rules for writing scientific notation for physical quantities, adjust the size of the notation correctly
Language Aspect	Avoid unnecessary words/phrases
	More customizable/consistent font sizes
Presentation Aspect	Improvements in image quality should be evident.
	Improvements to the concept map

Implementation

This implementation stage is carried out to apply the e-module design in learning. This implementation stage has gone through a development process and has been validated by three experts and has been implemented to 35 students of class XI SMA Negeri 6 Kota Bengkulu. This

stage is carried out to determine the feasibility and assessment of students regarding the e-module developed. At this stage students are given prettest questions and posttest questions to measure the level of students' problem solving skills after and after using the learning media made and given a student response questionnaire to find out students' responses to the use of physics e-modules based on the PBL model assisted by heyzine flipbook that has been developed. The results obtained at this implementation stage are presented in **Table 6**.

Table 6. N-gain Test Results

Aspect	Pre	Post	N-gain	Category
Understanding the problem	58,09	92,85	0,83	High
Plan the solution	37,79	90,77	0,85	High
Problem Solving	19,04	75,71	0,70	High
Rechecking	14,76	66,82	0,61	Medium
Total score obtained		**0,75**		**High**

Table 6. menunjukkan bahwa hasil perolehan N-gain dari tes *prettest* dan *posttest* memperoleh skor keseluruhan rata-rata 0,75 termasuk kategori tinggi sesuai dengan kategori N-gain pada tabel 3, sehingga dapat disimpulkan bahwa media pembelajaran berupa e-modul fisika berbasis model PBL berbantuan *heyzine flipbook* dapat meningkatkan kemampuan pemecahan masalah siswa pada materi hukum newton tentang gerak melalui keempat tahapan kemampuan pemecahan masalah yakni, memahami masalah, merencanakan penyelesaian masalah, menyelesaikan masalah, dan memeriksa kembali. Kemudian, respon peserta didik terhadap e-modul fisika berbasis model PBL berbantuan *heyzine flipbook* dapat dilihat pada **Table 7**.

Table 7. Student Response Results (N=35)

Assessment indicators	Total score	Maximum score	Percentage (%)	Average
Media Display	229	140	82%	
Media Usage	332	140	79%	81%
Benefits	567	140	81%	
Category				**Very Good**

Based on the results of student responses shown in table 7, it can be concluded that the results of student responses in each aspect, namely in the aspect of media display of 82%, the aspect of media use of 79%, and in the aspect of benefits of 81%, so that the overall percentage is 81% with the category “very good”. Based on these results, it can be stated that most students like physics e-module learning media based on PBL model assisted by heyzine flipbook.

Evaluate

The evaluate stage is a process to find out whether the interactive learning media developed is successful and as expected. Evaluation carried out at the four stages above is referred to as formative evaluation, because its purpose is for revision needs. In addition, this stage also requires summative evaluation, which aims to see the impact or results of the learning that has been implemented.

Formative evaluation is seen from the results of the analysis conducted by observation, interviews, and student needs analysis questionnaires. Based on the results of observations and interviews conducted with physics teachers stated that student interest in understanding physics material is still low and it is necessary to develop a learning media that is able to improve student solving skills and also student interest in physics material. Based on the results obtained, the value for needs analysis is 73.8% of students agree to develop learning media in the form of physics e-modules that can improve problem solving skills. Formative evaluation of the results of validation of learning media reviewed by the three experts obtained 86% with a category level very feasible to use. Formative evaluation of the N-gain results of the student response questionnaire obtained a result of 0.79 after the use of physics e-modules based on the PBL model with a high category level, so it can

be stated that this physics e-module can improve students' problem solving skills. Then, for the results of the response questionnaire distributed obtained a result of 81%, which is categorized as very good.

Summative evaluation of the evaluation at the end of the development process of physics e-modules based on PBL models assisted by heyzine flipbook successfully supports students in learning and understanding newton's law physics material about motion. This physics E-module learning media is also considered very feasible and good to be applied in physics learning to improve students' problem solving skills.

Discussion

Learner learning activities in e-modules are tailored to Newton's law material about motion. Each learning activity is designed by following the five steps of the PBL model, namely orienting students to the problem, organizing students to learn, guiding group experience, developing and presenting work, and analyzing and evaluating the problem-solving process (Pramudya et al., 2019). The following is a display of e-module activities developed with the presentation of problems in everyday life.

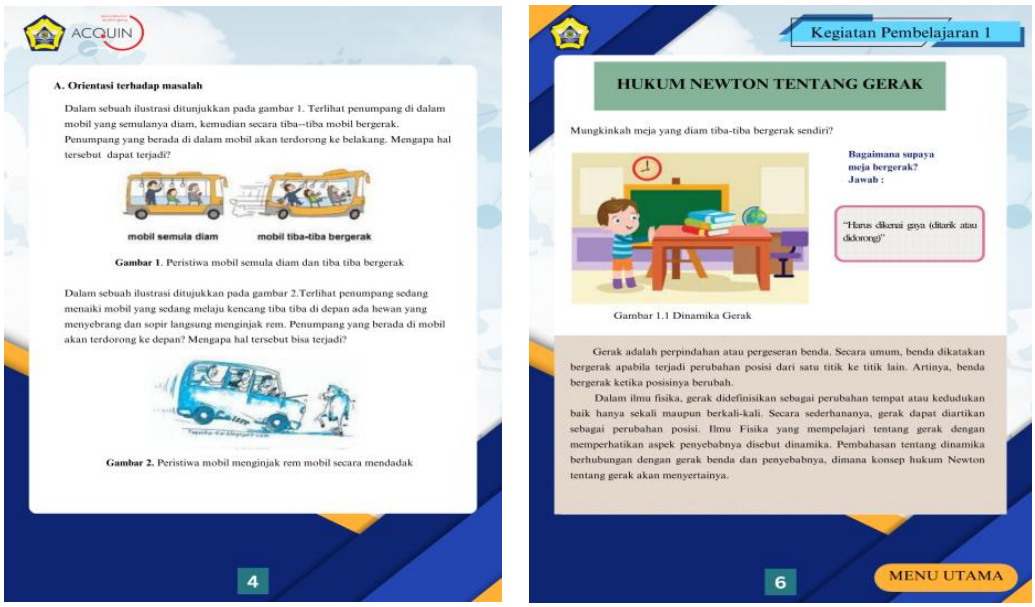

Figure 6. Display of the Initial Activity in the E-module

The steps of the PBL model can help learners to achieve the indicators of problem-solving skills. Figure 6 lists the steps of the PBL model in orienting students to the problem. The problem presented is a phenomenon of everyday life related to newton's law material about motion. The presentation of this problem can also support students to understand so that they can find problem solving from a problem (Nuraini, 2020). The presentation of this problem can also train students to interpret the problem. The second step of the PBL model is organizing students to learn. In the second stage, activities are shown by giving questions that spur the thinking process. It can also formulate the problem so that it leads to planning the solution (Pertiwi et al., 2023). Furthermore, the third step of the PBL model is filled with experiments through Phet simulation to investigate the relationship between force and mass and acceleration. In this step, students are expected to start implementing the solution plan by connecting ideas or the results of group discussions to existing theories (Suhendra, 2022).

Figure 7. Guiding students on experiments and presenting results

The fourth step is to develop and present the work. Learners have a role to display and present the results of the experiment in the learner worksheet. Learners are directed to present the results of their experiments. This activity can provide an opportunity for learners to review the results of experimental activities that have been carried out. Furthermore, the last step is to analyze and evaluate the problem-solving process by filling in evaluation questions from experimental activities. PBL steps in guiding learners in understanding the problem from planning to concluding back from the results of solving the problem. PBL learning has a good effect on problem solving skills compared to conventional learning. Problem solving ability has a very important role in learning physics to get good results, therefore the application of this PBL model can improve students' problem solving ability on the material being studied (Firmansyah et al., 2022). Students are required to understand a learning concept through situations and problems presented at the beginning of learning with the aim of training students to be able to solve problems.

The results showed that the PBL model-based e-module assisted by heyzine flipbook that had been developed obtained the results of the validity test in the category very suitable for use. This result is in accordance with the results of previous research Gita et al (2022), which states that the physics e-module based on the PBL model is very feasible and effective in improving problem solving skills. The results of this study are also in line with research conducted by Utari et al (2023), shows that the media is categorized as very good. The assessment results based on the expert validator's assessment of 80% with a fairly valid category and the practitioner validator of 93% with a very valid category and can be used in learning. In addition, the feasibility of e-modules based on aspects of content, presentation, and language can help students learn independently (Hasanah et al., 2021). The results of the feasibility of the e-module also show that the e-module developed is easily understood by students because it can be seen easily and there are clearly arranged instructions for use (Manzil et al., 2022). The advantages of the developed media are that the e-modules are systematically arranged with PBL step activities assisted by heyzine flipbook independently anytime and anywhere as long as they have a stable internet network. Sitompul et al., (2021) added that the presentation of digital learning media has an effect on students because the images presented digitally attract attention and make it easier to understand the problem. Thus, the development of physics e-modules based on the PBL model assisted by heyzine flipbook is feasible to use as learning media and effective for improving problem solving skills.

Based on the data listed in table 6, there are four indicators of problem solving ability, namely understanding the problem with a test result of 0.83 with a high improvement category. Planning problem solving obtained an N-gain value of 0.85 with a high category. Solving the problem obtained an N-gain value of 0.70 with a high category and for checking back obtained a test result of 0.60 with a medium improvement category. So it can be concluded that students' problem solving skills have increased with an overall average N-gain of 0.75 including the high category. From the results of the trial, differences in learning outcomes were obtained before using the e-module and after using the e-module.

At the end of the pilot test, students were asked to respond to the developed e-module. Student responses indicate the level of attractiveness of the e-module developed, obtained a category value of “very good”. This is in line with previous research by(Gita et al., 2022), which shows that the results of student perceptions have a level of attractiveness to the e-module developed, obtained a total

average value of 3.50 with the category “very interesting”. These results are also in line with research conducted by (Senja et al., 2024), shows that the results of student perceptions have an average result of 81% which is categorized as very good. Researchers argue that the existence of physics e-modules combined with the PBL learning model can improve problem solving skills, especially on the subject of Newton's law of motion because the form of learning media is practically attractive, and can be accessed in any situation, so it can be used independently.

The PBL approach integrated into the physics e-module showed a positive influence on improving students' problem-solving abilities, especially in terms of analytical skills, reasoning, and independent exploration. During the implementation, several obstacles emerged, such as low student readiness in independent learning and technical obstacles in the form of limited internet connection. This requires adjustments to the teacher's facilitation approach to continue to support students' thinking processes without losing the essence of problem-based learning. Compared to previous studies, the use of Heyzine Flipbook in this module provides added value in terms of interactivity and accessibility. The practical implications of these findings indicate that this e-module can be an alternative learning method in areas with limited school facilities.

4. CONCLUSIONS

Based on the results of the research and discussion, it can be concluded that (1) The physics e-module based on the PBL model assisted by the flipbook heyzine has gone through a validation process by experts to be used in the learning process on the physics material for grade XI SMA Newton's Law of Motion. (2) Based on the results of the N-gain level data, an average value of 0.75 was obtained with the "high" category. (3) In the assessment of the analysis of student responses to the physics e-module based on the PBL model, it showed 81% in the "very good" category.

Based on the research results and conclusions, there are several suggestions for further researchers, namely considering that the PBL-based physics e-module developed is only focused on Newton's law material, it is recommended to continue this research further with various physics materials so that the developed e-module is more effective and more widely developed so that the product is easily recognized by many users and can be tested in learning activities. In addition, the developed physics e-module can be an alternative media used by teachers in guiding learning in the process of finding problems to concluding problem solving according to physics theory.

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