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Implementation of the education for sustainable development (ESD) based predict, observe, and explain (POE) learning module to improve critical thinking skills

Implementasi modul pembelajaran predict, observe, and explain (POE) berbasis education for sustainable development (ESD) untuk meningkatkan kemampuan berpikir kritis

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Abstract
The learning model is needed so that students are actively involved in exploring and applying material concepts well. One is the POE (Predict-Observe-Explain) model, which can be used in the physics learning process, such as understanding concepts and their application in life. This study aims to test the effectiveness and determine the quality level of an ESD-based POE learning module. This study used a quantitative approach with a pre-experimental method through a one-group pretest-posttest design. The research occurred at SMK Muhammadiyah Lasem, and the sample was class X students. The instruments used were validation sheets and test sheets (posttest-pretest). The quality of the module is determined based on the categorization of validity, while the effectiveness is analyzed through the N-gain statistical test of critical thinking skills from the results of the pretest and posttest. According to material and media experts, the developed ESD-based POE module was very valid. The critical thinking skills demonstrated by N-gain also experienced a significant increase in the experimental class, which was 0.535, compared to the control class, which gained 0.12. The N-gain score of the experiment class is in the high category, and these results indicate that the ESD-based POE learning module effectively involves students actively in learning and applying the concepts they learn.

Keywords: Module implementation; POE learning; teaching materials; sustainable development

Abstrak. *Model pembelajaran diperlukan agar peserta didik terlibat aktif dalam mengeksplorasi dan menerapkan konsep materi dengan baik. Salah satunya yaitu model POE (Predict-Observe-Explain) yang dapat digunakan pada proses belajar fisika seperti memahami konsep-konsep serta penerapannya dalam kehidupan. Penelitian ini memiliki tujuan untuk menguji keefektivan dan mengetahui tingkat kualitas sebuah modul pembelajaran POE berbasis ESD. Penelitian ini menggunakan pendekatan kuantitatif dengan metode pre eksperimental melalui one group pretest posttest design. Penelitian bertempat di SMK Muhammadiyah Lasem dan sampelnya peserta didik kelas X. Instrumen yang digunakan adalah lembar validasi dan lembar tes (posttest-pretest). Kualitas modul ditentukan berdasarkan kategorisasi kevalidan, sedangkan keefektivan dianalisis melalui uji statistic N-gain keterampilan berpikir kritis dari hasil pretest dan posttest. Hasil penelitian menunjukkan modul POE berbasis ESD yang dikembangkan sangat valid baik menurut ahli materi maupun ahli media. Keterampilan berpikir kritis yang ditunjukkan oleh N-gain juga mengalami kenaikan yang signifikan pada kelas eksperimen yaitu 0,535 dibandingkan kelas kontrol yang memperoleh 0,12. Skor N-gain kelas eksperimen tergolong kategori tinggi dan hasil ini menunjukkan bahwa modul pembelajaran POE berbasis ESD efektif untuk melibatkan peserta didik aktif dalam pembelajaran dan menerapkan konsep yang dipelajarinya. Kata kunci: implementasi modul, pembelajaran POE, bahan ajar, pembangunan berkelanjutan.*

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INTRODUCTION

Planning and learning strategies are closely related to preparing a learning activity that a teacher will carry out in the classroom. Students' potential will be developed if the learning process is more student-centred and active learning. A learning strategy will determine various learning components, such as learning approaches, using learning methods, what learning materials will be delivered, how learning materials will be provided, how to hone students' abilities, and how to improve students' abilities, not only in the cognitive domain, will but also in the affective and psychomotor domains (Been, 2022). The learning process will be better if it is based on the constructivist learning theory that can build students' thinking. Constructivism theory is a learning theory that requires students to be active during learning and can construct their knowledge through discoveries during education so that it can be integrated with previous knowledge (Mulyani et al., 2018).

Teaching and learning activities also require teaching materials that can be used as learning resources. Teaching material is a device that contains learning material or content. One of the benefits of teaching materials for teachers is that it makes it easier for teachers to convey the material to be studied to students (Qomariah & Supardi, 2021). Teaching materials also have an essential role for students, which can help students better understand the material presented by the teacher. Teaching materials will be interesting if combined with learning models that can encourage students to predict or observe a phenomenon in teachers at schools where this research will teach, often explaining what is in textbooks from the first to the last page, even though it is true. In the curriculum approach, the subject matter development is the teacher's authority, but this space of educational freedom and democracy has not yet been utilized. The textbooks used also do not show realities outside the school world that can be related to physics learning material so that the teaching and learning process becomes more lively and enjoyable for students. So the authors got the idea to combine learning modules or books with learning models based on sustainable development or what can be called Education for Sustainable Development (ESD).

The basis for selecting the learning model in the research conducted is to demand that students be more active independently in the learning process that is being carried out. One learning model that provides opportunities for students to construct and develop their knowledge alone actively is the ESD-based POE (Predict, Observe, Explain) learning model. Learning activities in the POE learning model consist of Predict, Observe and Explain about a material that has been studied. In the POE learning model, the teacher acts as a facilitator, meaning that students actively find a solution to physics problems and guide students towards problem-solving (Safitri et al., 2019).

Learning using the POE model provides opportunities for students to explore their abilities through three stages of learning to create an independent and student-centred learning orientation (Wardana & Ardani, 2021). There are two competency standards for science study materials in POE learning: scientific work and understanding of concepts and their application (Novanto et al., 2021). Science is related to how to find out about nature systematically, so science is not only for mastering knowledge that contains facts, concepts, or work principles but also an invention, one example of science learning found at the SMK level, namely Physics.

Students think that physics lessons are difficult to understand, especially in abstract physics. In addition, students also have difficulty solving physics problems that require high analysis. This study chose static electricity material because the application of static electricity is easy to find in everyday life, and applications of static electricity are easy to reach, so this material is possible to learn according to its relation to daily events encountered by students. Based on the description above, it is hoped that research can apply and determine the effectiveness of learning modules or physics teaching materials to improve critical thinking skills in static electricity material by predicting, observing and explaining a phenomenon in everyday life.

RESEARCH METHOD

This study used a quantitative approach with a pre-experimental method through a one group pretest posttest design. The research took place at Muhammadiyah Lasem Vocational School and the sample was class X students. The instrument used to see an increase in critical thinking skills was a test in the form of

multiple choice questions totaling 20 questions with reliability (rxy = 0.877) in the very high category. The pretest was carried out before the implementation of the ESD-based POE Learning Module. After learning is complete, a posttest is carried out. Students' critical thinking skills can be identified through N-Gain analysis based on the results of the pretest and posttest. Critical thinking skills in research are limited to the ability to analyze and evaluate. The instruments used were validation sheets, pretest and posttest questions.

The parts proposed for validation are in the form of POE learning modules, lesson plans/modules, and worksheets. Learning Implementation Plan (RPP), as a guide for the implementation of learning activities that direct the improvement of critical thinking skills. Student Worksheets (LKS), to support student learning activities. The pretest-posttest questions are used to determine critical thinking skills. To determine the level of effectiveness of a module using student response data calculated using a Likert scale and to determine the level of product quality can be seen from the level of validity of the value that has been validated by experts and calculated using the product moment correlation. Arikunto (2018) reveals that "a test is said to be valid if the test can measure what it is intended to measure". Test the validity of the research instrument using the product moment correlation technique proposed by Pearson.

The validity data are calculated using Formula 1, and categorized using Table 1. While, students' critical thinking skills are calculated using the N-gain calculation in accordance with Formula 2, and categorized using Table 2.

$$r_{xy} = \frac{n\,\Sigma XY - (\Sigma X)(\Sigma Y)}{\sqrt{(n\,\Sigma X^2 - (\Sigma x)^2)(n\Sigma Y^2 - (\Sigma Y)^2)}}$$ .....Formula 1

Descriptions:
r_{xy} = Correlation coefficient
N = Number of research subject or student
ΣX = The total score of each question item
ΣY = The total score
ΣXY = The number of multiplication results between the item scores and the total score

$$N\ gain\ score = \frac{Posttest\ Score - Pretest\ Score}{Maximum\ Score - Pretest\ Score}$$ .....Formula 2

Table 1 Validity Level Category

Percentage (%)	Category
81-100	Very Valid
61-80	Valid
41-60	Pretty Valid
21-40	Less Valid
0-20	Not Valid

Table 2 N-gain Score Category

N-gain Score	Category
$g > 0{,}7$	High
$0{,}3 \leq g \leq 0{,}7$	Medium
$g < 0{,}3$	Low

RESULTS AND DISCUSSION

The learning problems at Lasem Muhammadiyah Vocational School consist of three aspects: aspects of the teaching methods used by teachers still using conventional systems, the learning process is still teacher-centred and does not use additional teaching materials. This model is quite time-saving in explaining something to large groups of people. Still, it must be remembered that this is quite a lot criticized because this model has a "poor" method of activity (between teachers and students) (Precious & Feyisetan, 2020). Such a situation negatively impacts students, so students become less active, independent and creative in learning and are less able to know independently. Teachers are expected to be able to sort out and choose the right strategies to use so that learning outcomes are effective and maximum (Mujahida & Rus'an,

2019). Critical thinking skills analyzed through this study are the ability to analyze and evaluate. This increase can be obtained by analyzing the results of the pretest and post-test.

Before the ESD-based POE learning module was implemented, students were given a pretest consisting of questions on the C3-C6 levels of Bloom's taxonomy in the cognitive domain, where these criteria are indicators of critical thinking skills. Learning modules or teaching materials that have been prepared present material and experimental activities as well as real questions in everyday life related to static electricity material in accordance with the basic competencies of the 2013 curriculum. Presentation of material and experimental activities as well as practice questions related to Everyday life makes it easier for students to be able to connect and associate subject matter with everyday life. The part of the module that has been prepared consists of three parts, namely: 1) opening section, 2) content section and 3) closing section.

The ESD-based POE Learning Module consists of several components which include the steps of the POE learning model, namely predict, observe and explain (Nugraha et al., 2019). At the predict stage, given a physics problem that students can find in everyday life regarding static electricity experiments, so that students can estimate the answer by recalling the knowledge they gained through the events that occurred. Of the 10 students, there were different opinions and reasons for answering. An example of an event that answered in accordance with the event he had experienced was about "the hand that was attached to the TV screen that just turned on, when it was brought closer, the hair on his hand would also rise." Many students answered by linking experiments carried out using hair combs. There are also those who answer that the static electricity experiment can be done easily if you use a plastic ruler.

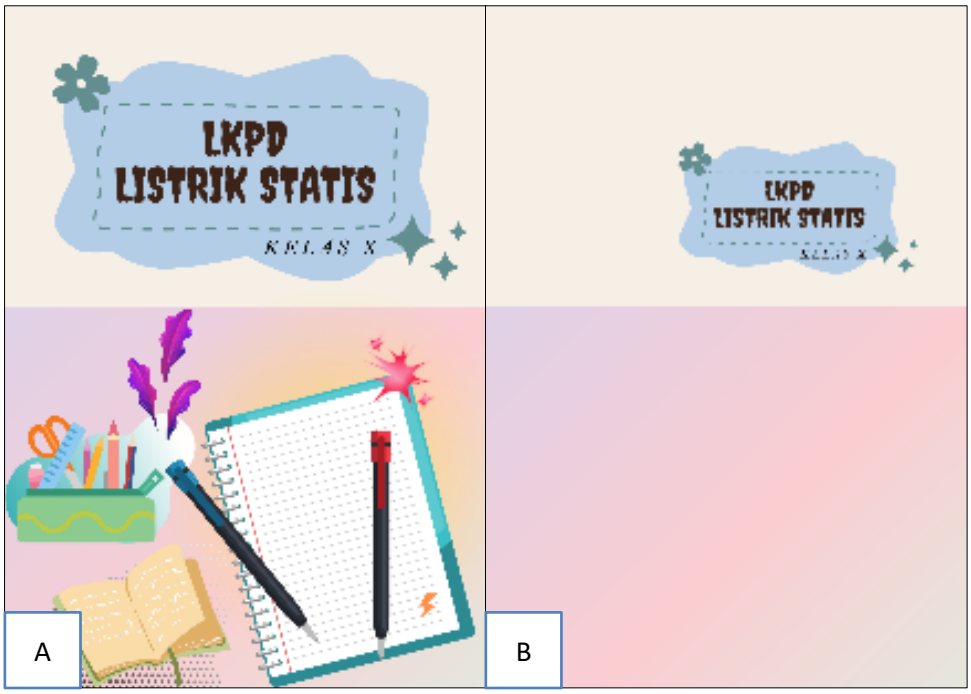


Figure 1 The front (A) and back (B) cover of LKPD (in Indonesia)

After the results are obtained in the predict stage, students will be guided to do practicum at the observe stage. Practicum conducted by students using tools that are often used in physics laboratories. In accordance with the problems given, practicum is carried out regarding the application of physics in life, so that the results can show the truth of their previous predictions. Students carry out practicums by paying attention to all the variables involved and the relationships between them. From the several POE LKPDs contained in the learning module, students have filled in, it is written that their predictions are in accordance with the practicum results, there are also those who write that the two are not related. The developed POE LKPD can be seen in details from Figure 1 to Figure 3. In the Figure 1, the LKPD cover is the first page of the LKPD which contains the title of an activity to be carried out. There are ornaments that can

attract students' interest in working on the LKPD. In this closing section there is a design image that is used as the cover behind the LKPD. The LKPD used is one of the LKPD made like a book.

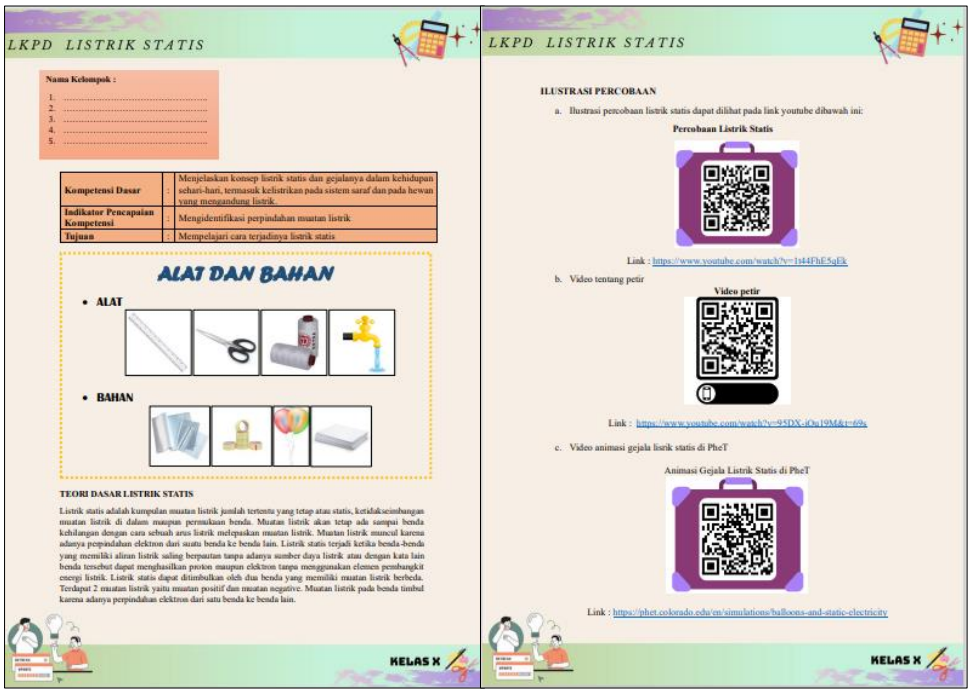


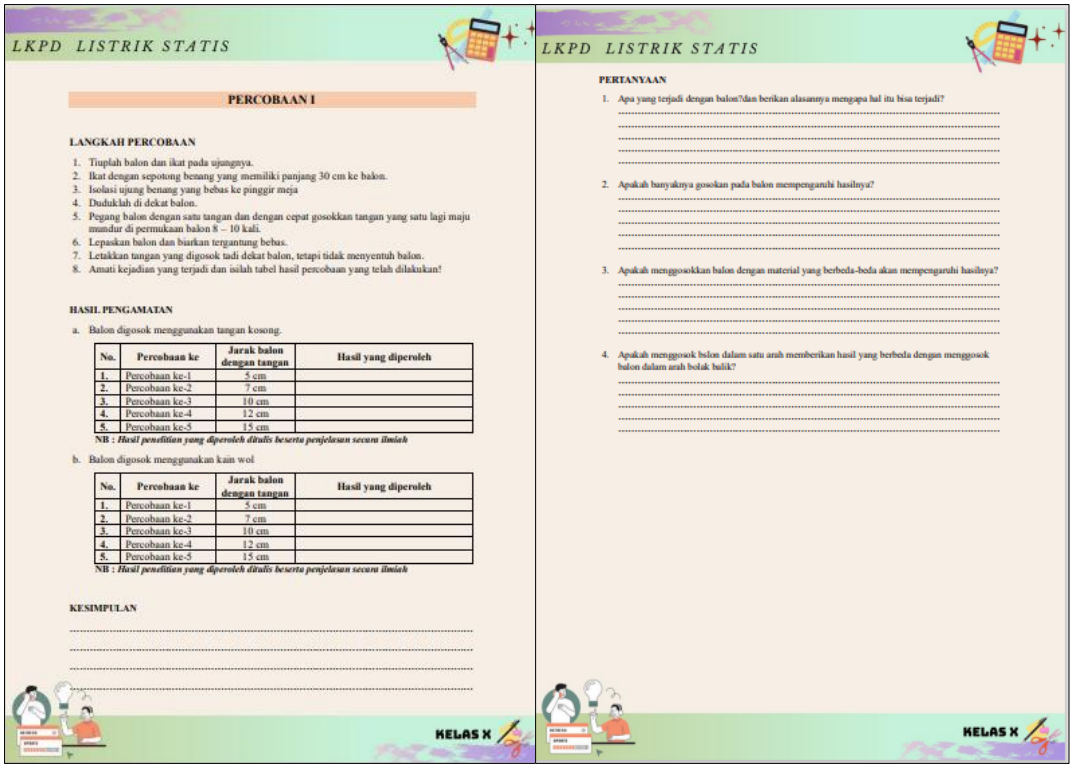
Figure 2 The introduction of LKPD (in Indonesia)

The introductory part of the LKPD in Figure 2 includes the tools and materials that will be used, and it also contains scientific information and illustrations of experiments that students, both video tutorials and experimental simulations in the form of animations in PheT, will carry out. The content section consists of 3 experiments, although only one is shown in Figure 3. Each experiment consists of several sub-steps: work steps, observations, conclusions, and questions. Each experiment students are invited to do different experiments.

1) Experiment I was about measuring the reaction of a balloon after it was rubbed with a hand that had been rubbed and a balloon that had been rubbed with a woolen cloth
2) Experiment II on HVS paper that will be pulled with a ruler and mica paper that has been rubbed with hair.
3) Experiment III on the movement of water on a plastic balloon/mica that has been rubbed with hair.

Students at the explained stage must explain the relationship between the prediction results and the practicum. Through these demands, students can build their thinking and connect the knowledge they previously had with the knowledge they just acquired through the POE learning module. In addition to answering analytical questions and being able to evaluate them at the end of the lesson, students are also required to analyze the data obtained through the practicum. These data are interrelated, so students can explore them to see the effect. Researchers carried out the preparation of this Learning Module to determine how effective the use of the module was in learning. The learning modules created can be seen with the storyboard in Figure 4 to Figure 10.

Figure 4 shows the front cover of the module, which is the first part of the learning module, contains information about the module title, displays images related to exciting learning materials, the identity of the module creator, and the identity of the students who will use the module. The back cover contains information about learning POE physics with Static Electricity material. Figure 5 shows the cover page and instructions for using the module. The cover page contains information on the module title, module author, class, logo, publisher, and year it was compiled. Instructions for using this module are divided into two parts: instructions for using the module for teachers and instructions for using the module for students.



LKPD LISTRIK STATIS

PERCOBAAN I

LANGKAH PERCOBAAN

1. Tiuplah balon dan ikat pada ujungnya.
2. Ikat dengan sepotong benang yang memiliki panjang 30 cm ke balon.
3. Isolasi ujung benang yang bebas ke pinggir meja
4. Duduklah di dekat balon.
5. Pegang balon dengan satu tangan dan dengan cepat gosokkan tangan yang satu lagi maju mundur di permukaan balon 8 – 10 kali.
6. Lepaskan balon dan biarkan tergantung bebas.
7. Letakkan tangan yang digosok tadi dekat balon, tetapi tidak menyentuh balon.
8. Amati kejadian yang terjadi dan isilah tabel hasil percobaan yang telah dilakukan!

HASIL PENGAMATAN

a. Balon digosok menggunakan tangan kosong.

No.	Percobaan ke	Jarak balon dengan tangan	Hasil yang diperoleh
1.	Percobaan ke-1	5 cm	
2.	Percobaan ke-2	7 cm	
3.	Percobaan ke-3	10 cm	
4.	Percobaan ke-4	12 cm	
5.	Percobaan ke-5	15 cm	

NB : *Hasil penelitian yang diperoleh ditulis beserta penjelasan secara ilmiah*

b. Balon digosok menggunakan kain wol

No.	Percobaan ke	Jarak balon dengan tangan	Hasil yang diperoleh
1.	Percobaan ke-1	5 cm	
2.	Percobaan ke-2	7 cm	
3.	Percobaan ke-3	10 cm	
4.	Percobaan ke-4	12 cm	
5.	Percobaan ke-5	15 cm	

NB : *Hasil penelitian yang diperoleh ditulis beserta penjelasan secara ilmiah*

KESIMPULAN

.....
.....
.....
.....

KELAS X

LKPD LISTRIK STATIS

PERTANYAAN

1. Apa yang terjadi dengan balon?dan berikan alasannya mengapa hal itu bisa terjadi?
2. Apakah banyaknya gosokan pada balon mempengaruhi hasilnya?
3. Apakah menggosokkan balon dengan material yang berbeda-beda akan mempengaruhi hasilnya?
4. Apakah menggosok balon dalam satu arah memberikan hasil yang berbeda dengan menggosok balon dalam arah bolak balik?

KELAS X

Figure 3 The content of LKPD, namely Percobaan I (in Indonesia)



Figure 4 The front (A) and back (B) cover of module (in Indonesia)

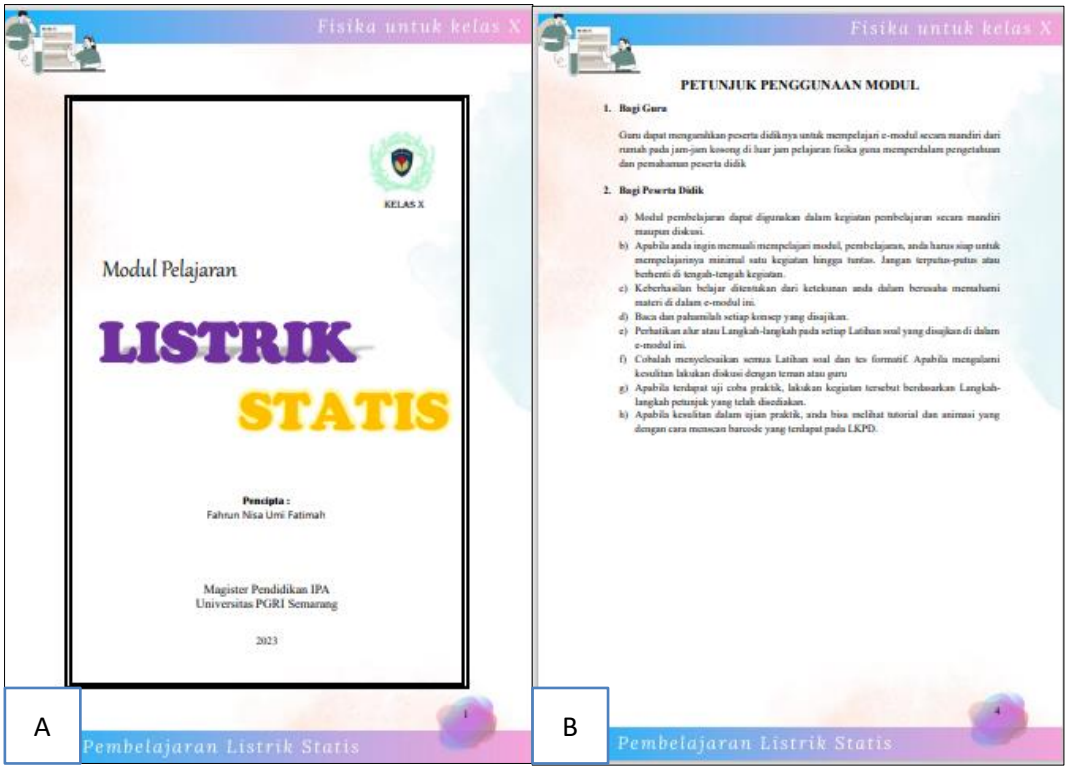


Figure 5 Cover page (A) and instructions for using the module (B) (in Indonesia)

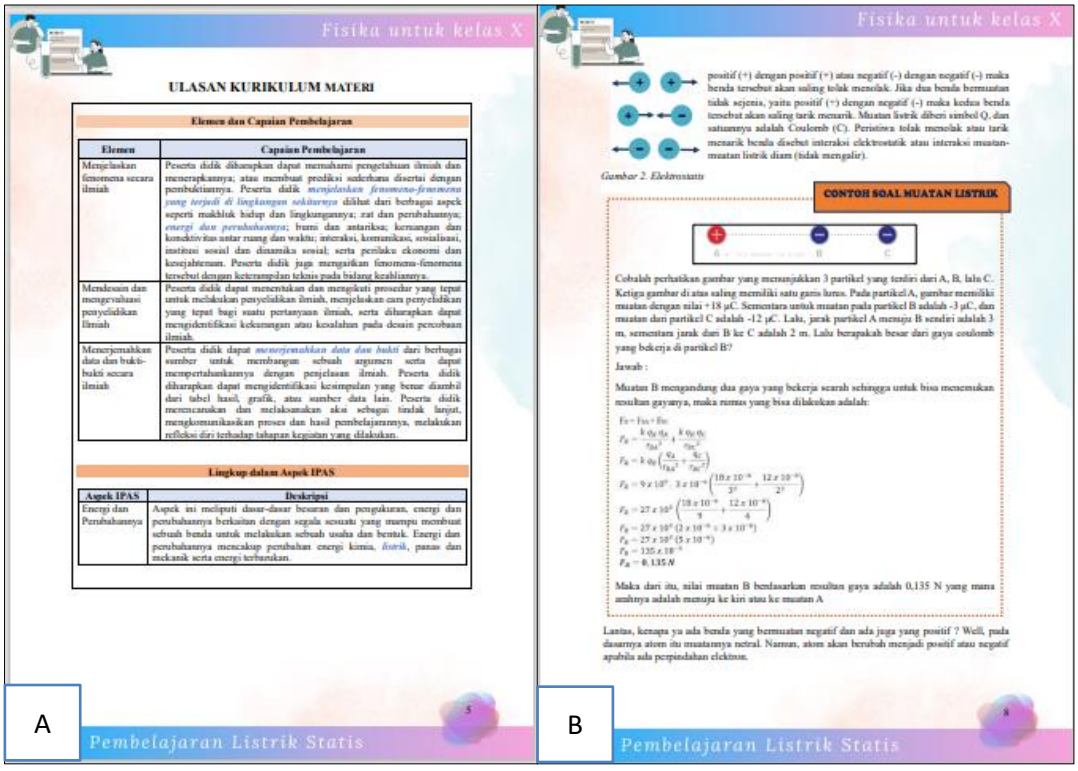


Figure 6 Review of curriculum material (A) and description of one of the module contents (B) (in Indonesia)



Figure 7 Predict stage (in Indonesia)

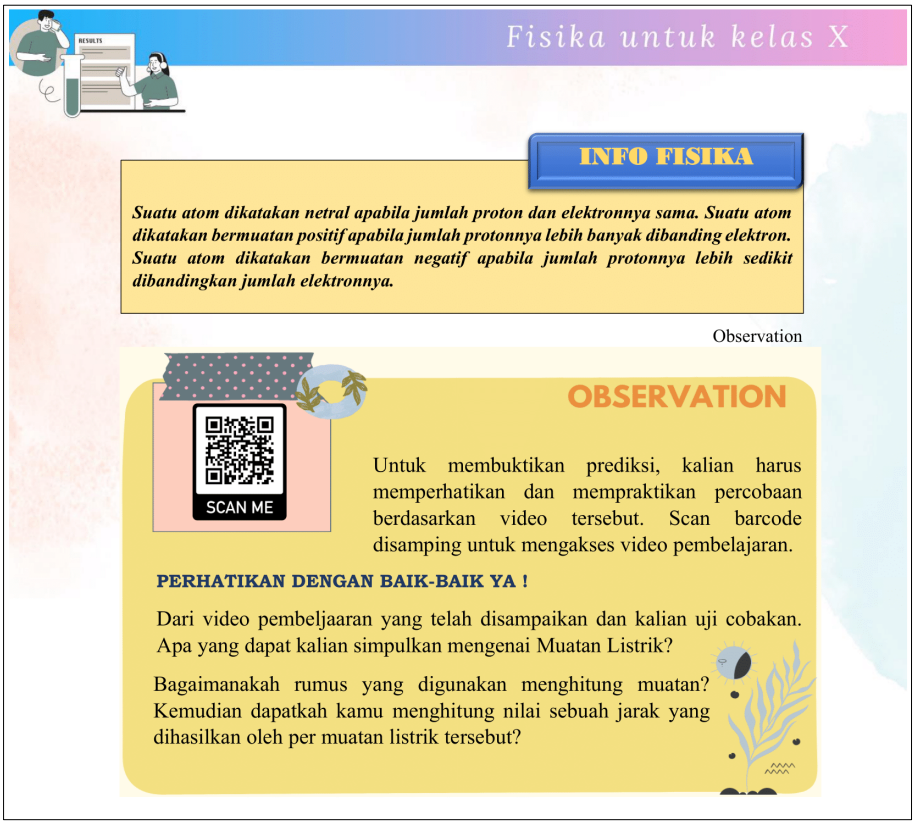


Figure 8 Observe stage (in Indonesia)

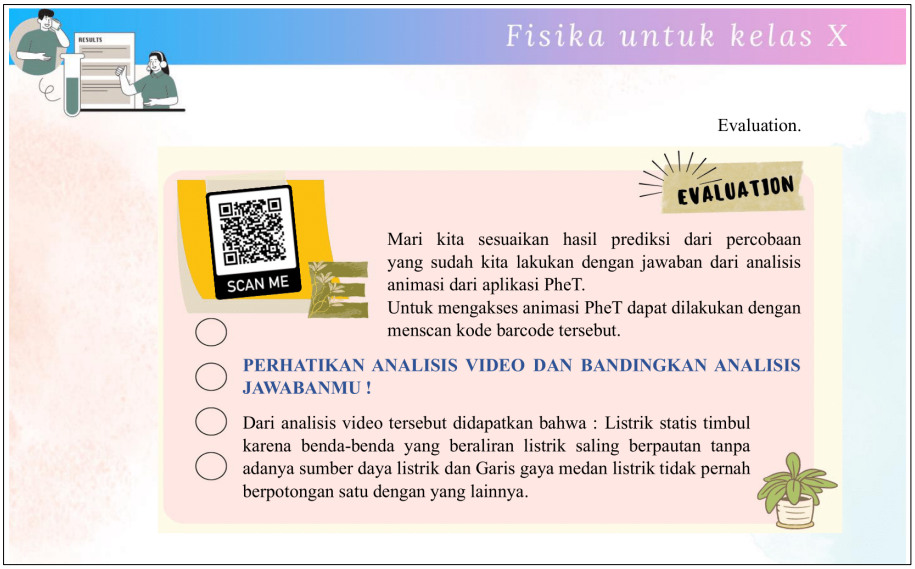


Figure 9 Explain stage (in Indonesia)

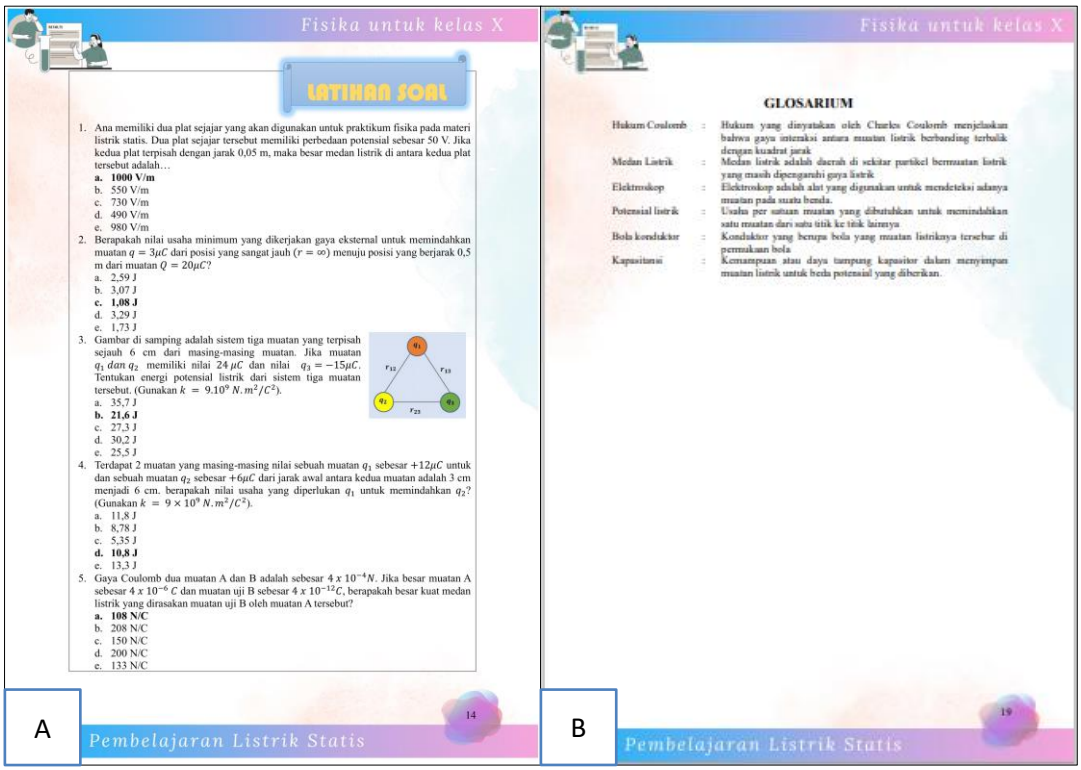


Figure 10 Evaluation tasks (A) and glossary (B) (in Indonesia)

Figure 6 shows a description of the curriculum and one of the contents of the module material. This part of the curriculum analysis is the task of the researcher. Before creating the module, students must analyze the current curriculum. This section of the curriculum analysis review consists of learning outcomes, learning elements, learning aspects of science and science descriptions of aspects of science that will be poured into the material. This learning module consists of teaching materials that will be taught in the learning process. This matter consists of electric charge, coulombs' law, electric field, electric potential, etc.

Figure 7 is the predict stage, where students are invited to see the opening video first, namely a video about predicting the occurrence of lightning. After students visit the video by scanning the barcode,

students are expected to understand more and know how to predict events around them. Figure 8 is the observe stage, where students are invited to make observations or trials, which can be done directly. Figure 9 is the explain stage, where students are invited to watch the video first to compare the results of the product evaluation with the results of the analysis evaluation contained in the learning video. Figure 10 is the closing section. This section includes practice questions that are used to test the level of students' ability to understand the material that has been presented. In addition, a glossary is used to help students understand keywords in learning.

The storyboard is a description containing visuals and explanations for each flowchart, with one column in the storyboard representing one display on the monitor screen (Rachmawati, 2020). After the draft LKPD and learning modules have been prepared, they are submitted for validation to experts. The validators in this study were four lecturers from the PGRI Semarang University. The validation results of 2 media expert validators and two material expert validators are shown in Figure 11.

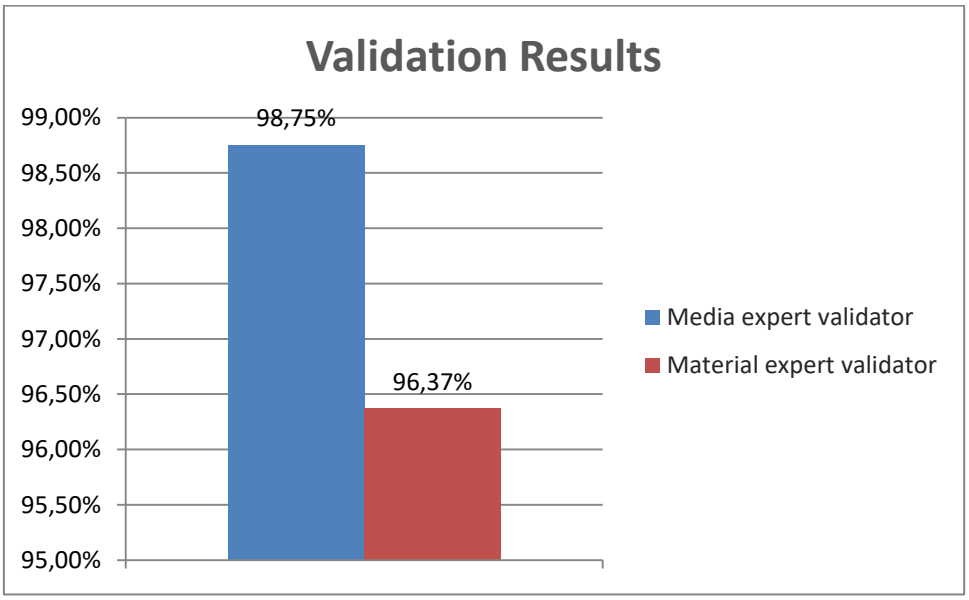


Figure 11 Validation results

Table 3 Recapitulation of N-gain Test Results

No.	Student Code	Experiment Class (Module)			Control Class (Non–Module)		
		Pre Test	Post Tes	N-Gain	Pre Test	Post Tes	N-Gain
1.	A	70	82	0,4	50	72	0,44
2.	B	60	83	0,575	80	72	-0,4
3.	C	72	81	0,32142857	50	56	0,12
4.	D	60	78	0,45	40	60	0,333333333
5.	E	68	80	0,375	40	78	0,633333333
6.	F	77	90	0,56521739	70	64	-0,2
7.	G	63	88	0,67567568	60	61	0,025
8.	H	50	77	0,54	50	60	0,2
9.	I	50	89	0,78	75	76	0,04
10.	J	60	87	0,675	77	78	0,043478261
Average		**63**	**83,5**	**0,53573216**	**59,2**	67,7	**0,123514493**

After the validator was carried out by obtaining an average value of 98.75% and 96.37% in the "fit to use" category, learning using the ESD-based POE learning module can get the results of the pretest, posttest, and N-Gain can be seen in Table 3. Based on the student's pretest and posttest values shown in Table 3, the results of the pretest and posttest scores were then statistically tested using the gain test and analysis of the development of critical thinking skills. Based on the Gain value obtained from the average

value, the value is 0.53573216, rounded to 0.54. The value of 0.54 is a medium category used in learning. The pretest and posttest values were tested for normality to determine whether the data was normal to decide on the statistics for further analysis. After being tested for normality, it was stated that the data were normally distributed, so the statistics used were parametric. The students' pretest and posttest scores were then analyzed and grouped into several categories. The analysis of the development of critical thinking skills shows an increase in critical thinking skills after being treated with the POE model.

The effectiveness of teaching material is carried out by ten students so that the results obtained are that the value of the experimental class that uses media has a higher average value than the control class that does not use learning media. The average score obtained by the experiment class was 63 for the pretest and 83.5 for the posttest, while the results for the control class (without using a module) were 59.2 for the pretest and 67.7 for the posttest. According to research by Qomariah & Supardi (2021), the average value of the pretest was 34.31. Then, the posttest was 62.05, with an N-gain test value of 0.52 which was included in the moderate classification, so the posttest had a higher value than the pretest, from the study. In this study, the researchers concluded that the POE model learning process was effective for training high school students critical thinking skills. Based on research results by Murtihapsari et al. (2022), looking at various aspects such as summarizing, classifying, explaining, exemplifying, interpreting, and concluding. All aspects studied have increased with an average value of 0.62, so it can be supposed that students' POE models can experience an increase in conceptual understanding. According to Shirajuddin et al. (2020), the lack of interest in student learning and the low knowledge of students' concepts will decrease student learning activities. Therefore, applying suitable models such as POE can improve students' understanding of concepts and learning activities.

Research by applying POE learning forms reveals that applying the POE model has the highest aspects in thinking skills and developing mastery of concepts, and using the POE model for students also makes it easier to grow scientific concepts by themselves and match them to pre-existing theoretical concepts (Fatimatuzzohrah et al., 2020). Analyze the application of POE to see students' competence to think critically while learning chemistry on thermochemistry material. This study used test instruments and observation sheets. The results obtained with the critical thinking sub-indicator are N-Gain 0.7921. So it is concluded that the POE model can improve students' critical thinking skills (Cahyati, 2019). The results of research that have been carried out in class XI at SMAN 1 Rawajitu Selatan, namely the POE learning model, influence students' critical thinking skills, as seen from the tests that have been carried out using the chi-square test, hypothesis testing using the contingency table, with each value of 17.25; 9.49 ($Xhit \geq Xtab$) with α = 0.05. POE learning models such as predicting and observing cause students' critical thinking skills to increase (Fitrianingsih et al., 2021). These studies show that the application of the POE model has a significant effect on improving thinking skills and developing mastery of concepts.

CONCLUSION

Based on the results of the development research that has been carried out, it can be concluded that the ESD-based POE learning module is implemented using three stages of learning: predict, observe and explain. The learning modules developed have very valid quality modules. It also was found that the ESD-based POE learning module got the medium category by N-gain score of learning outcome that aims to improve students' critical thinking skills.

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