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Development of Student's Worksheet Integrated with Predict Observe Explain (POE) Model to Facilitate Students' Critical Thinking Skills

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Abstract: Critical thinking ability is one of the important skills that need to be improved to face the 21st century. In learning physics, appropriate teaching materials are needed and can improve students' critical thinking skills so that students can increase their learning independence. The purpose of this research is to develop student worksheets integrated with the Predict Observe Explain (POE) learning model to facilitate student's critical thinking skills. The type of research used in this study is Research and Development (R&D) with the Borg and Gall model modified into six stages, namely potential and problems, data collection, product design, product validation, product revision, and product trial. The research instruments used were expert validation sheets, teacher practicality sheets, and student practicality sheets. The data analysis technique used was descriptive statistics. The results of this study are the average value of the validity of the student worksheet product is 0.82 which is categorized as valid, and the average value of practicality according to the teacher is 98% and the average value of practicality according to students is 90% with a very practical category. therefore, the use of student worksheets integrated with the POE model is valid and practical in learning physics.

Keywords: Critical thinking ability; POE model; Student's worksheet

Introduction

The development of the 21st century has a very significant influence on human life. The 21st century requires every individual to be able to master many abilities to compete in the current era of globalization. To achieve the ability of this century requires an education that can increase everyone's mastery in various fields to face the times. Education today demands the achievement of 21st century skills in students (Sari et al., 2020). These abilities include a broad understanding focused on knowledge, attitudes, and abilities that are based on what students need in school, work, and their lives. The 4C abilities critical thinking, creative thinking, communication, and collaboration are the competencies that students must acquire in order to succeed in education today (Sundari & Sarkity, 2021).

One of the higher-order thinking skills that students must have to fac6e the challenges of the 21st century is critical thinking skills (Alismail & McGuire, 2022). Ability to think is the ability to use your mind to find meaning and understand something, and to explore concepts, make decisions, think about solutions with the best judgment, and revise problems in the previous thinking process (Arifin, 2017). The ability to think critically or what is commonly referred to as critical thinking is an ability that a person has to be able to think clearly or rationally to make a reasonable decision on a problem based on the information obtained. Rational thinking itself means having beliefs and views that are supported by appropriate, relevant, and reliable evidence (Sundari et al., 2018). Critical

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thinking skills themselves are an essential skill that students must have to equip themselves to finish a learning (Nurlela & Ismayati, 2015).

According to Facione (2011), the following indicators interpretation, analysis, assessment, inference, explication, and self-regulation can be used to assess critical thinking abilities. After conducting a literature study, it is known that students' critical thinking skills are still in the low category with a percentage of 35.91%, the percentage of achievement of each indicator is 71.19% for interpretation, 25.53% in analysing, 27.14% for evaluation, 32.86% in inferencee, 36.67% in explication, and 32.38% for self-regulation (Arini & Juliadi, 2018). Due to the existing deficiency in critical thinking skills, it is imperative that the educational system in Indonesia focuses on enhancing students' critical thinking abilities. Consequently, educators should promote the development of critical thinking skills by employing learner-centered teaching methods or models (Kibirige et al., 2014).

Learning that is carried out is inseparable from the use of teaching materials. Educational materials play a crucial and significant role as learning resources in school subjects, aiming to enhance teacher effectiveness and boost student achievement (Asrizal et al., 2017). Teaching materials have a major influence on success in achieving learning objectives (Husnita & Saputri, 2023). According to Prastowo (2015), teaching materials encompass various resources such as information, tools, and texts that are thoughtfully organized and utilized by educators and students during the learning process to accomplish educational goals. Effective teaching materials are those that aid students in their learning journey and enhance their capabilities. Student worksheets are one example of such teaching materials that can support the development of students' critical thinking skills (Aldila et al., 2017).

Student's worksheet is one of a teaching material in the form of paper containing a summary of material and instructions for learning activities that refer to basic competence (BC), indicators, and the intended educational goals that students are expected to attain (Prastowo, 2015). According to Haryonik and Bhakti, this student's worksheet is expected to assist students in carrying out learning activities independently, where students can carry out learning activities by the steps in the student's worksheet (Haryonik & Bhakti, 2018). The use of this student's worksheet can also help teachers in carrying out knowledge assessment or ability assessment by the standards in the curriculum used. In physics learning, student's worksheet is needed because student's worksheet provides many benefits for students and teachers. Incorporating learner worksheets, into the learning process has several positive outcomes. It makes students' learning experiences more enjoyable, fosters interactivity, offers opportunities for active practice, and serves as a motivating factor for students during their educational journey (Puspita & Dewi, 2021).

In addition to being supported by teaching materials, physics learning must also be supported by the use of the appropriate model. The use of this model can support the achievement of the expected learning objectives. The model used must be updated according to the concept of material, interests, and characteristics of students. The success of physics learning can be achieved by applying the right model and can make the cognitive abilities and critical thinking skills of students can increase. One of the models that teachers can use in learning physics is the predict observe explain (POE) model. POE is a model that consists of three stages, namely predicting, analyzing, and concluding (Yulianto et al., 2014). According to research conducted by Suyanto, it was found that the POE model is more efficient in enhancing students' critical thinking abilities (Suyanto et al., 2012).

The anticipated optimal conditions do not align with the actual conditions observed in the field. As evidenced by the findings from the preliminary study, issues are prevalent in the realm of physics education, particularly concerning students' critical thinking abilities. An assessment of students' critical thinking skills can be derived from the outcomes of the critical thinking skills examination administered to them. The subsequent table is analyzation of student's critical thinking skills at SMAN 6 South Solok.

Table 1. Description of Critical Thinking Ability

Critical thinking indicators	Average student score	Criteria
Interpretation	42	Low
Analysis	48	Low
Evaluation	25	Very Low
Inference	35	Very Low
Exsplication	24	Very Low

Based on Table 1 above, the average critical thinking ability of students is still in a very low category with a value of 35.64, and still needs to be improved in this critical thinking ability. Hence, it is crucial for educators to address this issue in order to enhance students' critical thinking abilities. The deficiency in critical thinking skills can be attributed to teachers not incorporating teaching materials that facilitate the development of these skills. Consequently, there is a necessity to advance both the learning process and its assessment by implementing instructional tools that actively engage and nurture students' critical thinking skills (Putra, 2015).

Based on interviews with physics teachers that have been conducted at SMAN 6 South Solok, it appears that in learning physics teaching materials used have not facilitated students' critical thinking skills. Teaching materials commonly used by teachers are modules, printed books and sometimes use students worksheet. Based on the analysis of the worksheets used by physics teachers, there are several weaknesses in the worksheets. The weaknesses include, among others, the worksheets used are still focused on discussion activities and only a few practical activities, and the worksheets used have not been able to help students to develop critical thinking skills. Therefore, a student worksheet is needed that can be used to improve students' critical thinking skills.

Based on the results of teacher interviews, it is also known that teachers have used various learning models such as problem-based learning and project-based learning, but the model is not optimal. The use of learning models affects the activeness and enthusiasm of students' learning. Generally, students are more interested in learning outside the classroom such as learning by experimentation, observation, and others. However, in the real situation in the field, learning is still mostly done in the classroom so students are easily bored during the learning process. The use of the right learning model is needed because the learning model can make learning more interesting. Therefore, the use of the POE model is one solution that can be used, where this model is more centered on students to carry out experimental activities.

Based on the analysis of student needs, it is known that 95% of students need student worksheets that can improve critical thinking skills. Students need learning resources such as (student worksheets) that can help them understand physics ideas, direct practicum, and help them develop critical thinking skills. According to research by Puspita et al. (2021) student's worksheet can support students' understanding of and confidence in their ability to solve critical thinking challenges.

It is known that students' low critical thinking skills require special attention and must be improved. One solution that can be given to be able to improve students' critical thinking skills is to develop teaching materials that can facilitate students' critical thinking skills. based on teacher interviews and analysis of students' needs, it is also known that teachers and students need teaching materials that can facilitate students' critical thinking skills in physics learning. the solution that can be given is to develop student worksheets that are integrated with the POE model. student worksheets integrated with the POE model are expected to be able to support students' critical thinking skills that are still low.

Based on the explanation above, it is known that students' critical thinking skills are still low and the teaching materials used by teachers cannot facilitate students' critical thinking skills. Therefor, it is necessary to research on the development of teaching materials. The purpose of this research is to develop student's worksheet integrated with the predict observe explain (POE) model to facilitate students' critical thinking skills.

Method

The research methodology employed in this study is Research and Development (R&D). R&D is utilized for creating new products and enhancing existing ones. It is a systematic approach to refining educational materials through research that involves various methods. Development research serves as a method for creating fresh products, models, procedures, techniques, and tools by employing specific problem analysis and methodologies (Sugiyono, 2018).

The research and development procedure according to Sugiyono(2018) has ten stages, but in this study it is only limited to six stages, namely up to the product trial stage. The steps to be carried out are shown in Figure 1.

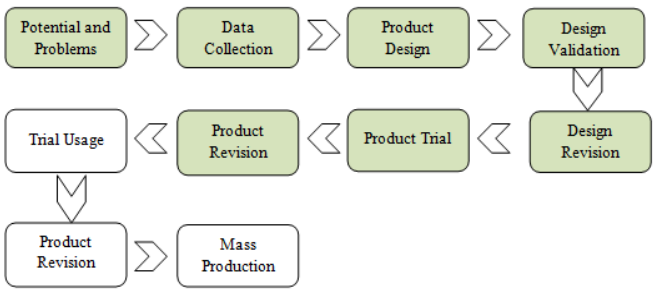


Figure 1. Research flow

Research begins as a response to potential and problems. Potential refers to anything that, if utilized, can provide added value. Problems, on the other hand, represent the gap between expected results and the actual situation. These potentials and problems were identified at SMAN 6 South Solok, and this identification came from observations made during the preliminary study in the field and interviews to physics teachers.

Data collection in this study was carried out by conducting an initial study. The initial study was carried out to know how physics learning in schools. Initial data collection can be done through observation of student needs questionnaires, and student critical thinking questions. After the data is collected, data analysis is then carried out using the percentage technique with the following equation.

$$\text{Average score} = \frac{Obtained\ Score}{Max\ Score} \times 100\% \quad (1)$$

The product design stage starts with designing or creating a prototype 1 framework that will be developed. The initial prototype 1 framework contains cover, learning instructions, basic competencies, supporting information, work steps, and assessment. After the prototype 1 design is made, the making of the initial prototype 1 to be validated can be developed.

The next stage is product validation, this stage aims to find out whether prototype 1 is valid or not. Data on the results of the validation of prototype 1 that has been made is seen from a questionnaire filled out by six experts. The validity test questionnaire is prepared based on a Likert scale. The Likert scale used is modified from Riduwan et al. (2008) which consists of five categories. The first category is strongly disagreed with a percentage achievement of 0%-20%, the second category is disagreed with a percentage achievement of 21%-40%, the third category is neutral with a percentage achievement of 41%-60%, the fourth category is agreed with a percentage achievement of 61%-80%, and the fifth category is strongly agreed with a percentage achievement of 81%-100%.

Aiken V's validation index was then used to assess the data that came from expert validation. Following that, the data was examined using the Aiken V validation index, which is created as follows.

$$V = \frac{\Sigma s}{n(c-1)} \quad (2)$$

S = r – lo

The category of validity was used Aiken's V index (1985) which indicates that 0.79 (invalid) and over 0.79 (valid).

After validation by experts, the next step is to revise prototype 1. Product revision is used to improve the various deficiencies contained in prototype 1. The revision of prototype 1 was carried out by the comments and suggestions given by the experts. After revising prototype 1, prototype 2 was produced which could be tested on teachers and students.

The purpose of the product trial phase was to evaluate the viability of the manufactured prototype 2. Data on the practicality of prototype 2 can be seen from the results of teacher and student responses in the form of practicality questionnaire results. The Likert scale is the basis for the weighting. The steps for analyzing the practicality questionnaire are as follows: first, use the Likert scale to determine the practicality questionnaire's criteria. The following equation is then used to assess the data gathered from the practicality questionnaire responses.

$$\text{Practicality} = \frac{Obtained\ Score}{Maximum\ Score} \times 100\% \quad (3)$$

After obtaining the results of the practicality test, the score interpretation criteria based on Riduwan & Warsiman (2008). In very practical criteria in the interval of 81%-100%, practical criteria in the interval of 61%-80, quite practical criteria in the interval of 41%-60%, less practical criteria in the interval of 21%-40%, and impractical criteria in the interval of 0%-20%.

Result and Discussion

The study followed the development model by Borg and Gall, as detailed in Sugiyono (2018). This model consists of ten stages, but this study limited to six stages, namely: recognizing potential and problems, collecting data, designing the prototype, validating the design, revising the design, and conducting product trials. The result of each stagesare explained below.

Potential and Problems

Research departs from the existence of potential and problems. Potential is anything that if used will have added value. A problem is a gap between what is expected and the facts on the ground. The results of these potentials and problems were obtained from initial observations made at SMAN 6 South Solok. The observation aims to find out what potentials are found in the school, and the problems that occur in the school (Sohibun & Ade, 2017). Initial observations were conducted in the form of interviews with physics teachers at SMAN 6 South Solok. The things that were focused on the interview activities were about the curriculum used, the teaching materials used by the teacher in teaching, the methods used by the teacher in teaching, and how the learning outcomes and critical thinking skills of students.

The results at this initial stage obtained the potentials that exist at the school are, the school has used the 2013 curriculum; the school is equipped with laboratory facilities along with practicum tools; and the school has used the 2017 Ministry of Education and Culture books and other text books. In addition to the potential, it is also known that the problems that exist in schools are, the 2013 curriculum has not changed the way physics is taught; instruction is still teacher-centered; teachers and students seldom use the physics lab oratory for experiments; and the teaching materials have not been able to help students develop their critical thinking abilities.

Data Collection

Data collection in this study was carried out by conducting an initial study. The initial study was conducted to know how the implementation of physics learning in schools. This data collection was obtained from the results of a questionnaire analyzing student needs and giving critical thinking questions to students. The analysis of student needs was carried out by distributing questionnaire sheets to 26 students of class XI MIA 3 SMAN 6 South Solok, where this needs analysis serves to see the needs of students for teaching materials for physics learning. One of the teaching materials needed by students' is student worksheets. Based on the questionnaire, it showed that 90% of students need student worksheets in physics learning. Then 83% of students choose to use printed student worksheets and 13% of other students choose student worksheets in electronic form.

Next, students' critical thinking skills is done by giving critical thinking skills questions. Critical thinking indicators used are indicators from Facione (2011). The results showed that for interpretation indicators 42 score (low category), analysis indicators with score of 48 (low category), evaluation indicators with score of 25 (very low category), inference indicators with score of 35 (very low category) and explication indicators with score of 24 (very low category). The average result of critical thinking skills obtained was 36.04 with a very low category. Based on these results, it is known that the critical thinking skills of students at SMAN 6 South Solok are still very low. This is in line with research conducted by Arini & Juliadi (2018) that students' critical thinking skills are in the low category.

Product Design

The following outcome is the design of student's worksheet integrated with the POE model to foster students' critical thinking skills. The design of prototype 1 adheres to the guidelines for developing student's worksheet established by the Ministry of Depdiknas (2008). Prototype 1's have several components such as a cover/title, instructional guidelines, Basic Competences (BC), supplementary information, instructional procedures, and assessment/evaluation. Prototype 1 are structured in accordance with the POE model's framework, which comprises three distinct phases: predict, initial predictions are formulated, observe for practical application, and explain for drawing conclusions. The design of prototype 1 is presented as follows.

Cover

Cover is the outer part of the student's worksheet which functions as a protector of the student's worksheet. The prototype 1 cover contains the identity and characteristics of the teaching material itself. The cover contains the title of the student's worksheet made, the author's name, the logo of the institution, the name of the institution, the identity, and images that represent the material contained. The cover is made using attractive colors and images. The cover of prototype 1 can be seen in Figure 2.

Figure 2. Cover design

Instructional

Learning instructions can be used as a guide for students in using prototype 1 and facilitate the process of learning activities. The learning instructions section consists of student identity, instructions for using prototype 1 for students, and rules for practicum implementation. The display of learning instructions can be seen in Figure 3.

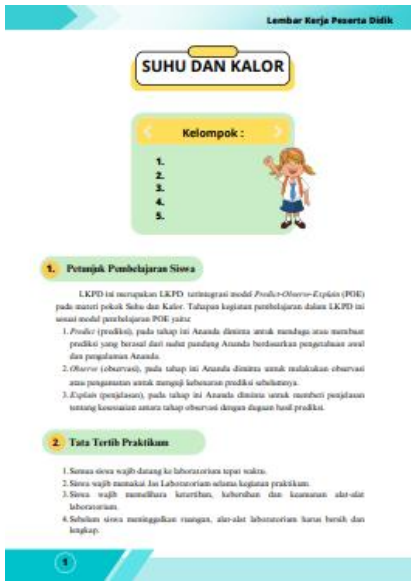


Figure 3. Learning directions

Basic Competencies

The formulation of basic competencies can be done by looking at the applicable curriculum. The competency section includes basic competencies, learning indicators and learning objectives to be achieved. The formulation of indicators must be adjusted to the basic competencies used. The indicators added are the elaboration of KD 4.5 and KD 4.6 and as a measuring tool to be achieved, while the learning objectives serve to provide clear direction for learning activities. The display of basic competencies can be seen in Figure 4.

Figure 4. Basic competency design

Supporting Information

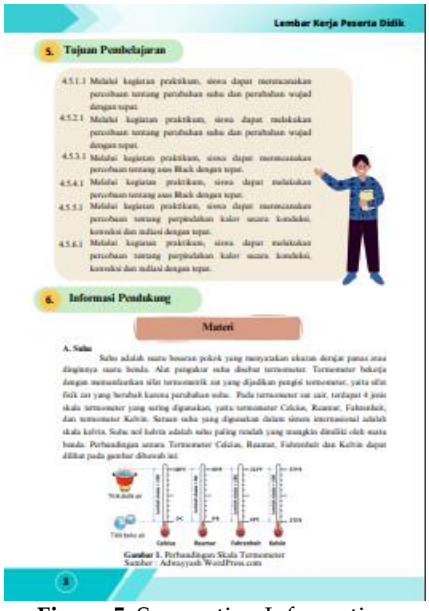


Figure 5. Supporting Information

The supporting information section contains the basic theory of learning and also the references used. This theoretical basis contains a brief explanation of the material that students will work on as a reference in completing practicum activities. In addition to containing material, the supporting information section also contains references that serve to show the source of the material to be studied. The display of supporting information can be seen in Figure 5.

Work Seps

Activities for the practicum that follow the Predict Observe Explain approach are included here. This component of the activity is structured according to the Predict Observe Explain (POE) model's phases.This section contains the initial hypothesis (prediction) of students about the practicum to be carried out, then the observation section which contains practicum materials, details of activities, data analysis, then the conclusion section (explanation) in this conclusion section students are asked to link their initial predictions with the results of observations made. The display of work steps can be seen in Figure 6.

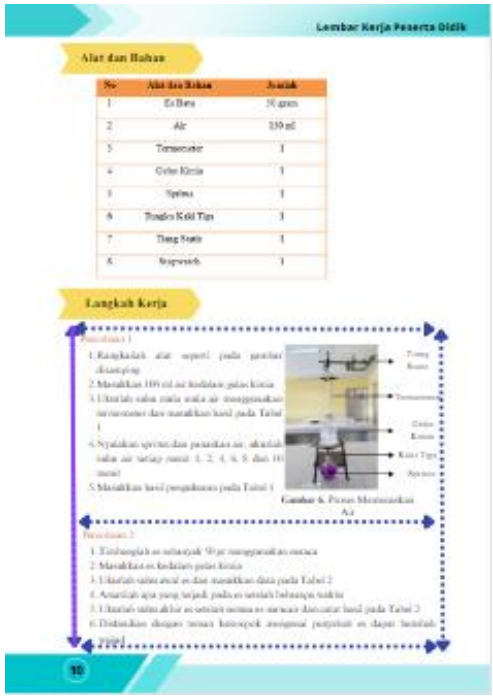


Figure 6. Learning step design

Assessment

The assessment section contains questions that students must do after the practicum and the assessment table. The assessment display section can be seen in Figure 7.

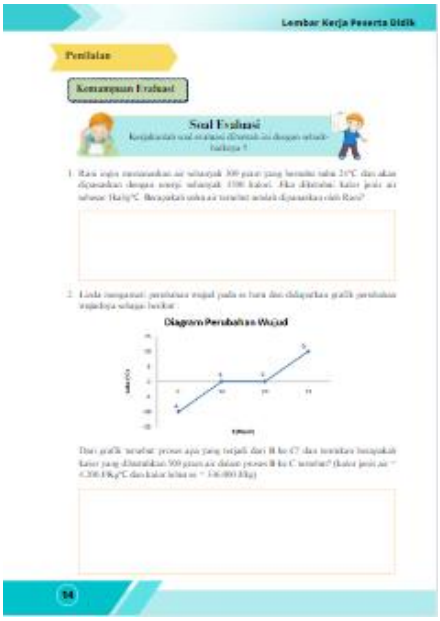


Figure 7. Assessment questions

Furthermore, the validity test was carried out on Prototype 1 that had been made.

Product Validation

The results at this stage are the results of the validation of prototype 1 that has been made. Product validation aims to determine the feasibility and quality of prototype 1 that has been made. One of the main criteria in determining whether an student's worksheet can be used or not is the result of expert validation (Dermawati et al., 2019). The instrument used in this validation is a product validity sheet that has been previously validated by experts and the instrument has been declared valid. Validation was carried out by six experts, namely physics lecturers at FMIPA Universitas Negeri Padang.

The validation sheet consists of six components, namely content feasibility, linguistic feasibility, presentation feasibility, graphical feasibility, POE model feasibility, and critical thinking skills indicator feasibility. The validation of these six components is in the value range of 0.79 to 0.94. The value obtained from the content feasibility component is 0.8 with a valid category, and the value of the language component is 0.82 with a valid category. The value of the presentation component is 0.8 with a valid category, the value of the graphic category is 0.94 with a valid category, the value of the POE model category is 0.82 with a valid category, and the value of the critical thinking indicator component is 0.79 with a valid category. Based on this data, the average value of the validation components is 0.82, in other words, all components in prototype 1 are in the valid category, so they are suitable for use in the physics learning process.

The validation results can be seen in the average value plot for all validation test components which can be seen in Figure 8.

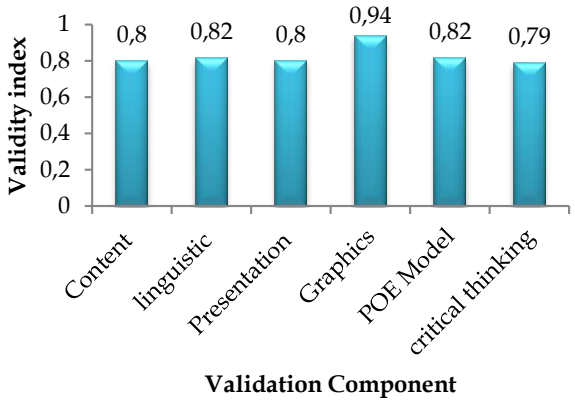


Figure 8. Result of component validation of product

The results of the product validation assessment are described based on the respective indicators for the six components of the prototype 1 assessment. The first validation component assessed is content feasibility which consists of four indicators, namely the student's worksheet based-POE made is by the Basic Competence and Competency Achievement Indicators; student's worksheet based-POE made is by the needs of students; Student's worksheet POE contains the correct substance of the material; and student's worksheet based-POE made contains the latest phenomena in everyday life. The graphical plot of the validation results for the content eligibility component can be seen in Figure 9.

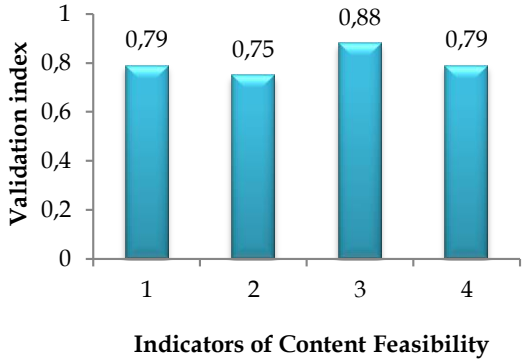


Figure 9. Validation score on content feasibility

Based on Figure 9. it can be seen that the indicators on the content feasibility component are in the value range of 0.75 to 0.88. Based on the value of the four indicators, the average value for the content feasibility component is 0.80 with a valid category. This means that prototype 1 is by the provisions of the preparation of student's worksheet.

Linguistic feasibility is the second validation component that is evaluated. The four indicators that make up the linguistic feasibility component are as follows the student's worksheet based-POE phrases are easily readable; the content on the student's worksheet based-POE is comprehensible; the writing on the student's worksheet based-POE is comprehensible; Writing on student's worksheet POE adheres to proper and appropriate Indonesian language standards; and student's worksheet based-POE makes effective and efficient use of language. Figure 10 shows the graphical depiction of the linguistic feasibility component validation results.

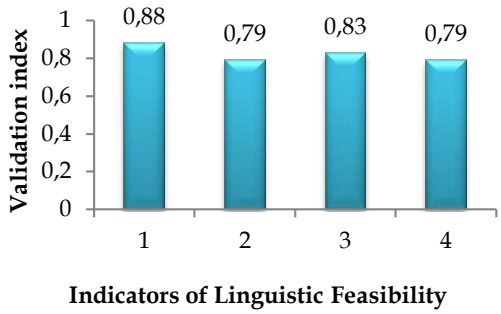


Figure 10. Validation scores on the linguistic feasibility

Based on Figure 10, it can be seen that the indicators on the linguistic feasibility component are in the value range of 0.79 to 0.88. Based on the value of the four indicators, the average value for the linguistic feasibility component is 0.82 with the valid category. This means that the language contained in prototype 1 is by good and correct Indonesian language rules.

Presentation feasibility is evaluated as the third component of validation. The nine indications that make up the language feasibility component are as follows: the student's worksheet based-POE has explicit learning objectives; the title given on the student's worksheet based-POE is by the content; the learning instructions presented on student's worksheet based-POE are clear and easy to understand; the formulation of Basic Competence (BC) presented on student's worksheet POE is correct and by the material; Supporting information presented on student's worksheet based-POE is clear; the work steps presented in the student's worksheet based-POE are clear and easy to understand; assessment/Evaluation presented in student's worksheet based-POE is correct; the presentation structure in student's worksheet based-POE is systematic; and student's worksheet based-POE has clear activities and can create interaction in the learning process. The graphical plot of the validation results for the linguistic feasibility component can be seen in Figure 11.

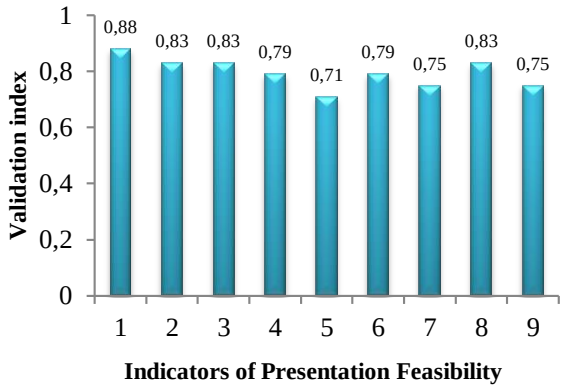


Figure 11. Validation score on presentation feasibility

Based on Figure 11. it can be seen that the indicators on the presentation feasibility component are in the value range of 0.71 to 0.88. Based on the value of the nine indicators, the average value for the presentation feasibility component is 0.80 with a valid category. This means that prototype 1 is by the structure of the preparation of student's worksheet based on the provisions (Depdiknas, 2008).

The fourth validation component assessed is the feasibility of graphics. The component of grammatical feasibility consists of four indicators are, the student's worksheet based-POE uses a type and size of font that is proportional; student's worksheet based-POE uses the right layout and subtitle layout; student's worksheet based-POE uses interesting illustrations, images, and photos; and the display design on student's worksheet based-POE is good. The graphical plot of the validation results for the grammatical feasibility component can be seen in Figure 12.

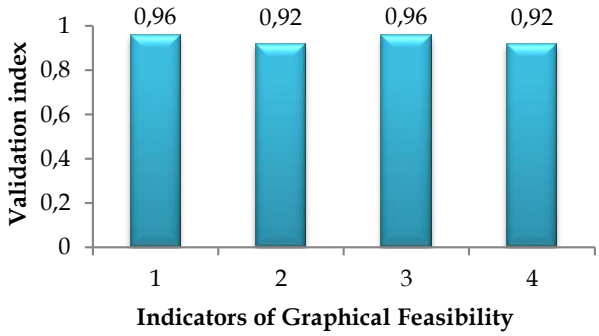


Figure 12. Validation score on the graphic feasibility

Based on Figure 12. it can be seen that the indicators in the component of grammatical feasibility are in the range of values 0.92 to 0.96. Based on the value of the four indicators, the average value for the feasibility component of the graphic is 0.94 with a valid category. This means that prototype 1 made is attractive and suitable for use in physics learning.

The fifth validation component assessed is the feasibility of the predict observe explain (POE) model in the student's worksheet. The POE model feasibility component consists of three indicators are, thestudent's worksheet based-POE contains prediction steps that can help students predict or make conjectures about a phenomenon; student's worksheet based-POE contains Observation steps that can help students in conducting experimental activities; and student's worksheet based-POE contains an Explanation step that can help students explain the suitability between conjectures and experimental results at the observation stage. The graphical plot of the validation results for the feasibility component of the POE model can be seen in Figure 13.

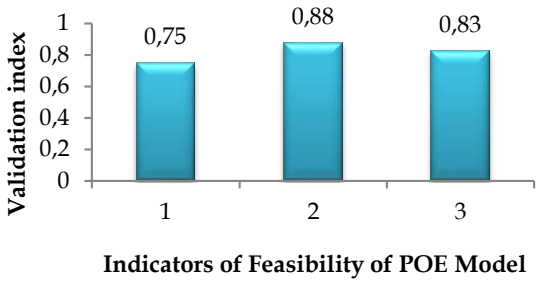


Figure 13. Validation Scores on the POE Model Feasibility

Based on Figure 13, it can be seen that the indicators on the feasibility component of the POE model are in the value range of 0.75 to 0.88. Based on the values of the three indicators, the average value for the feasibility component of the POE model is 0.82 with the valid category. This means that prototype 1 is by the steps of the predict observe explain (POE) model.

The last validation component assessed was the feasibility of critical thinking skills indicators. The feasibility component of the KBK indicator consists of six indicators, namely the student's worksheet based-POE can facilitate students' interpretation skills in describing and expressing the meaning of a phenomenon; the student's worksheet based-POE can facilitate students' analytical skills in determining the relationship of concepts used in solving problems; the student's worksheet based-POE can facilitate students' evaluation skills in writing problem solutions; the student's worksheet based-POE can facilitate students' inference skills in concluding; the student's worksheet based-POE can facilitate students' explication ability in writing the final result; and the student's worksheet based-POE can facilitate students' self-regulation skills in providing reasons for the conclusions drawn and reviewing the answers written. The graphical plot of validation results for the feasibility component of critical thinking indicators can be seen in Figure 14.

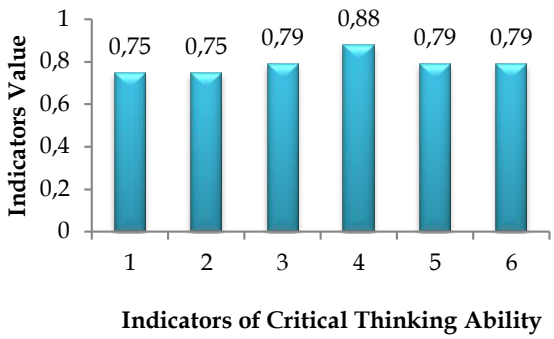


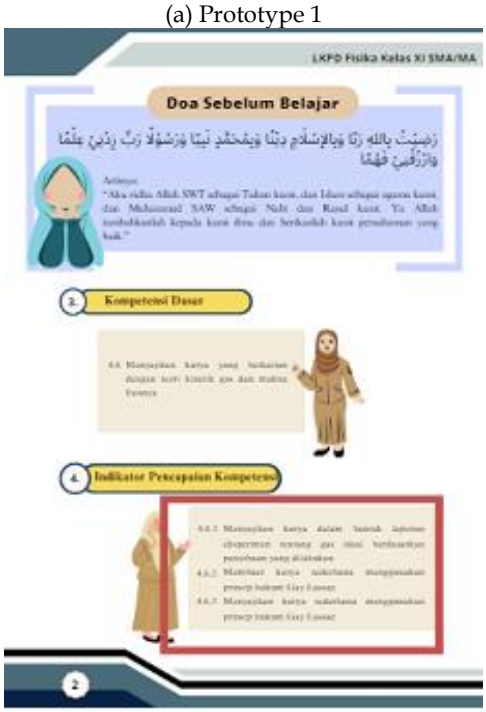
Figure 14. Validation scores on the critical thinking feasibility

Based on Figure 14, it can be seen that the indicators in the feasibility component of the KBK indicator are in the value range of 0.75 to 0.88. Based on the value of the six indicators, the average value for the feasibility component of the KBK indicator is 0.79 with the valid category. This means that prototype 1 can facilitate students' critical thinking skills in physics learning.

Design Revision

Validator input or suggestions were used as a reference to make revisions to prototype 1. Revisions to prototype 1 are intended to produce prototype 2 which will be used for product trials. The revisions made were the content feasibility component because the basic competencies and lesson indicators were still not appropriate, and adding learning materials that were still lacking. The component of linguistic feasibility was revised in writing sentences that were not yet effective and fixing typo words. The presentation feasibility component was revised in the learning objectives section because the learning objectives were still not by the indicators, then improvements were also made to the practicum work steps, data tables, data analysis, and evaluation questions. The component of the feasibility of graphics was revised in the unclear images, and the provision of image sources, and improvements were made to the layout of prototype 1. The POE model feasibility component was revised in the prediction activity section because the phenomena listed were still difficult to understand, and could not facilitate students in predicting. The critical thinking indicator feasibility component was revised in the interpretation indicator and analysis indicator section, in the interpretation indicator section it was made more interesting and easy for students to understand and the analysis indicator section of the questions made to explain the relationship of concepts obtained during practicum activities.Further improvements to the appearance of the presentation component can be seen in Figure 15.

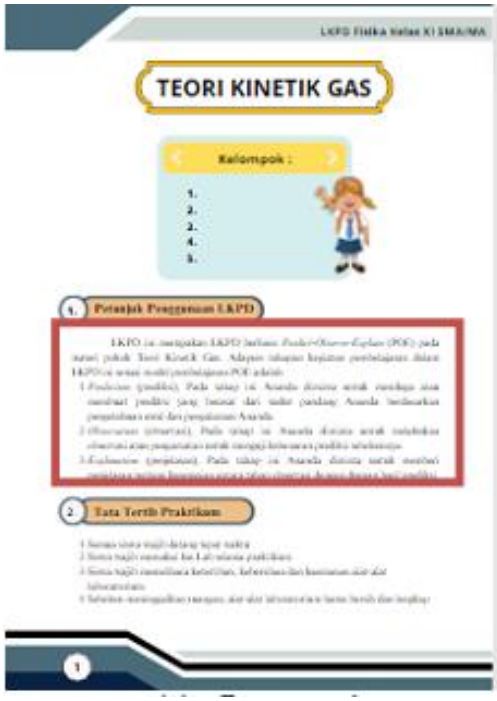
(a) Prototype 1



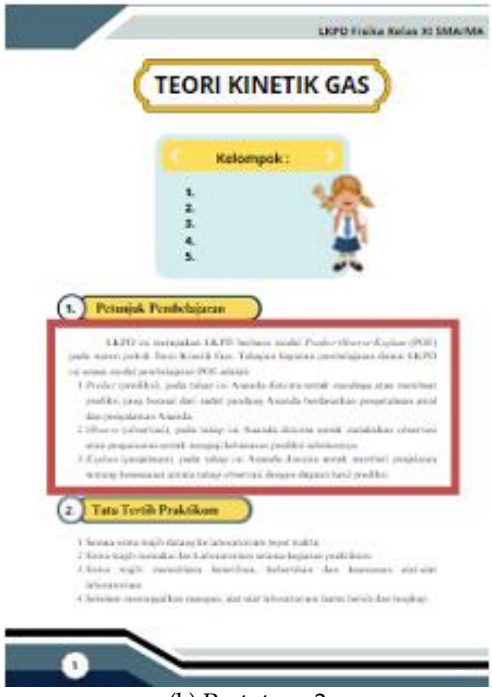
(b) Prototype 2

Figure 15. Improvement of learning indicators

Based on Figure 15, it can be seen the results of the revision of the content feasibility component in the prototype 1 indicator section. The validation results obtained from experts, obtained suggestions that the indicators in prototype 1 were not by KD 4.5 and KD 4.6. This revision aims to make the indicators in prototype 1 by the KD used. The writing of prototype 1 indicators before validation can be seen in figure (a), while the writing after validation can be seen in figure (b). Furthermore, the improvement of the language component can be seen in Figure 16.



(a) Prototype 1

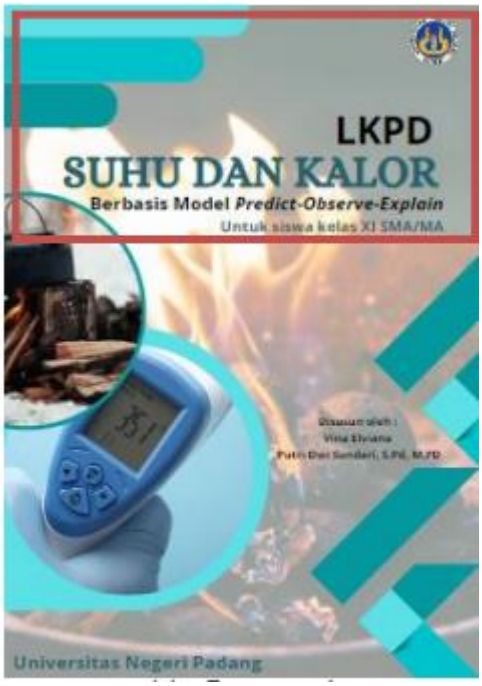


(b) Prototype 2

Figure 16. Sentence improvement on learning directions

The findings of the linguistic feasibility component's amendment in the learning instructions section are displayed in Figure 16. Conjunctions shouldn't start a sentence, according to the validation results from experts, and sentence composition is still not following the criteria. The goal of this revision is to

fulfill and adhere to Indonesian language norms in the sentence writing of prototype 1. The writing of prototype 1 indicators before validation can be seen in figure (a), while the writing after validation can be seen in figure (b). Moreover, Figure 17 illustrates how the presentation component has improved.



(a) Prototype 1

(b) Prototype 2

Figure 17. Cover display improvement

The results of the revision of the presenting feasibility component on the cover are shown in Figure 17. The outcomes of expert validation revealed recommendations that the cover's title is inappropriate and that the 2013 curriculum logo needs to be incorporated. The goal of this redesign is to improve the clarity and aesthetic appeal of prototype 1's cover. The writing of prototype 1 indicators before validation can be seen in figure (a), while the writing after validation can be seen in figure (b). Furthermore, the improvement of the graphic component can be seen in Figure 18.

(a) Prototype 1

(b) Prototype 2

Figure 18. Improved Layout of Subtitles and Images

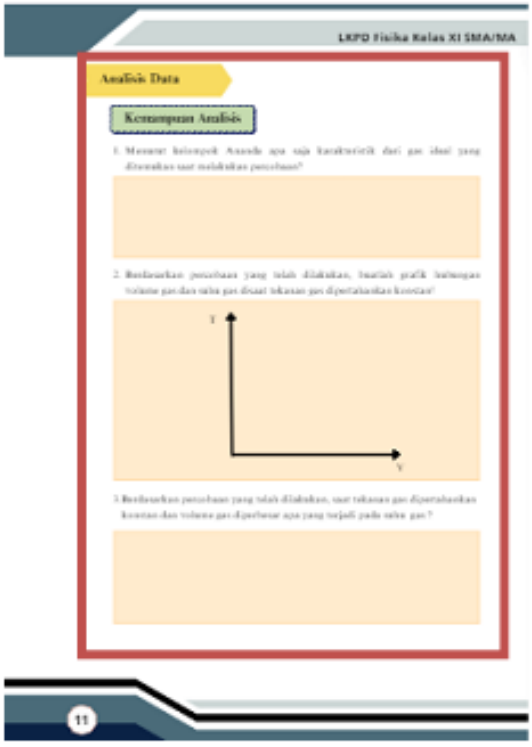
(a) Prototype 1

(b) Prototype 2

Figure 19. Improvement of Predict Activity

Based on Figure 18, it can be seen the results of revisions in the graphic section. The results of validation obtained from experts obtained suggestions that the lay out and subtitles in prototype 1 are still confusing, the use of images must be in accordance with the phenomenon, and the source must be included in the image section. This revision aims to make prototype 1 easier for students to understand. The writing of layout improvements and image improvements on prototype 1 before validation can be seen in Figure (a), while the writing after validation can be seen in Figure (b). Furthermore, the improvement of the POE model feasibility component can be seen in Figure 19.

(a) Prototype 1



(b) Prototype 2

Figure 20. Improvements to the analytical ability section

Based on Figure 19, it can be seen the results of the revision in the prediction activity section. The results of validation obtained from experts obtained suggestions that the sentences in the prediction section are difficult to understand and the questions have not been able to describe the prediction ability itself. This revision aims to make prediction activities in prototype 1 younger understood by students and can find out students' prior knowledge. The writing of predict activity improvements on the student's worksheet based-POE before validation can be seen in Figure (a), while the writing after validation can be seen in Figure (b). Furthermore, the improvement of the critical thinking indicator feasibility component can be seen in Figure 20.

Based on Figure 20 it can be seen the results of the revision in the analysis ability activity section. The validation results obtained from experts obtained suggestions that the questions for data analysis are further improved, add questions to make the magnitude relationship so that students can find the concept correctly. This revision aims to make the data analysis activities in prototype 1 can train students' critical thinking skills and facilitate students in finding the concepts learned. The writing of predicted activity improvements on the student's worksheet based-POE before validation can be seen in Figure (a) while the writing after validation can be seen in Figure (b). After making revisions to prototype 1 and the resulting output is prototype 2 which will be tested on students and teachers.

Product Trial

A Practicality test of the student's worksheet based-POE was conducted on 26 students of SMAN 6 South Solok and 1 physics teacher of SMAN 6 South Solok. The practicality assessment was conducted following the product revision stage, subsequent to the validation process. This practicality evaluation was limited to a single activity related to the topic of heat temperature and gas kinetic theory. Its purpose was to assess the suitability of prototype 2 for use by both students and teachers in the learning process. The practicality assessment utilized a practicality test sheet instrument, which had previously undergone validation and was confirmed as valid.

The practicality test was designed to determine how practical Prototype 2 was for learning activities related to heat temperature material and gas kinetic theory. After a short explanation, students were asked to use Prototype 2 in groups because it is a student's worksheet practicum. Students are asked to carry out each learning activity on prototype 2 based on the predict, observe, and explain model steps. The implementation of the practicality test on students can be seen in Figure 21.

Figure 21. Practicality test implementation

The data obtained from the student practicality test on prototype 2 predict part can be seen in Figure 22.

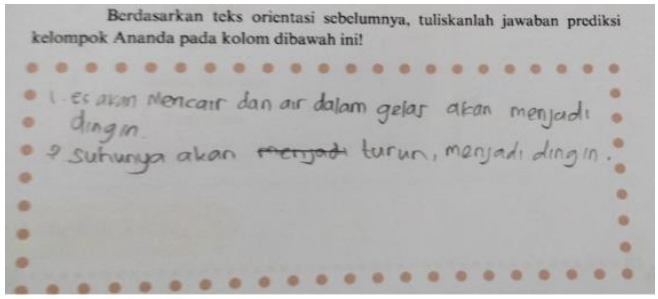


Figure 22. Student responses to prototype 2 part (predict) on caloric temperature and gas kinetic theory

Based on Figure 22, it can be seen that students' answers in the predict section show that students answered incorrectly. This shows that students do not understand the material of heat temperature and gas kinetic theory. Students predict or provide an initial hypothesis about the phenomenon given in the predicted activity. then students are asked to carry out experimental activities in groups in the observe section related to the phenomenon statement in the predict section, this activity aims to prove the students' answers in the predict section. This experimental activity aims to build student activeness and students' critical thinking skills in finding information (Natalia et al., 2021). The practicality test process in the observed activity can be seen in Figure 23.

Based on Figure 23, students are asked to conduct experimental activities to observe the material of heat temperature and gas kinetic theory. Students are asked to follow each work step in prototype 2. When conducting experiments in groups, students are more active and enthusiastic in carrying out learning activities, especially in experiments on gas kinetic theory material. After obtaining data from the experiment, students are then asked to conclude the

results of their experiments and the results are connected to the answers to the phenomena in the predict section. the following are student responses to the explain section which can be seen in Figure 24.

Figure 23. Implementation of the practicality test of observe activities

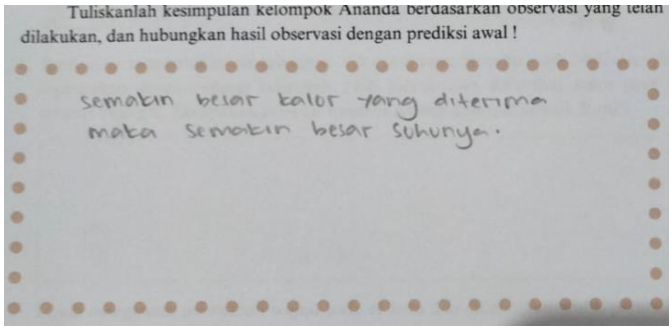


Figure 24. Student responses to the POE (explain) in student's worksheet on temperature heat and gas kinetic theory

Figure 24, show student response in the explain section which shows that students have answered correctly and have related to the answer to the question in the predict section, this conclusion is obtained after conducting the observation experiment. Students can compare the answers to the predicted results and the answers in the observe experiment section. This proves that students' concept understanding and critical thinking skills have improved. Students who at the beginning of learning do not understand the concept and can even be said to have misconceptions have improved after learning using prototype 2.

Additionally, teachers and students completed the practicality test questionnaire following the testing of prototype 2. The practicality test questionnaire sheet consists of multiple parts, including utility, efficiency, attractiveness, and simplicity of use. There are multiple assessment indicators associated with teacher and student answers to prototype 2 in each component. Figure 25 below shows the plot results of the average value of the practicality test for teachers and students for each component: ease of use; attractiveness; efficiency; and benefits.

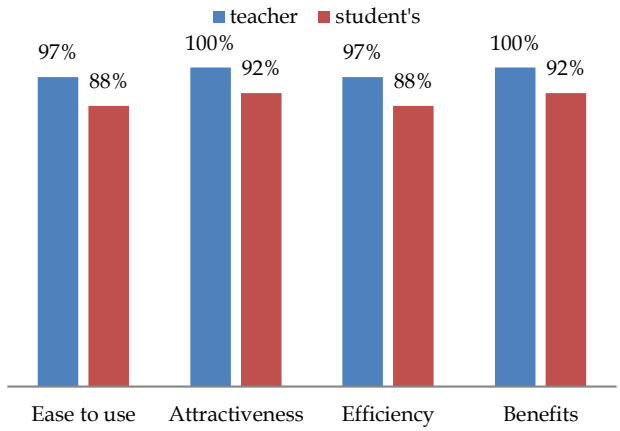


Figure 25. Overall average value of teacher and student practicality components of student's worksheet based-POE

Based on Figure 25, it can be seen that the teacher's practicality test components obtained scores in the range of 97%-100%. The highest value is in the attractiveness component which is 100 and the benefits with a value of 100, The high value of the trial in the attractiveness and benefits component according to the teacher means that prototype 2 is very interesting and very useful to use. The other two components, namely ease of use and efficiency, have a value of 97 which is included in the very practical category. After averaging all components are in the very practical category with a value of 98. So it is concluded that prototype 2 is very practical to use in physics learning based on the practicality test assessment by the teacher.

Based on Figure 25, it can be seen that the student practicality test components obtained scores in the range of 88%-92%. The results showed that for ease of use component with score of 88%, the attractiveness component with score of 92%, the efficiency component with score of 88%, and the benefit component with score of 92%, which for each component in the very practical category. After averaging all components are in the very practical category with the average value of 90%. So it is concluded that prototype 2 is very practical to use in physics learning based on the assessment of practicality tests by students. After the student and teacher practicality tests, suggestions from students and teachers were obtained which will be used in the revision of prototype 2 to produce products in the form of student's worksheet based-POE to facilitate students' critical thinking skills.

This research is relevant to research conducted by Permatasari et al. (2018) entitled "Development of Poe-Based Lkpd for Learning Physics on Momentum and Impulse Material for High School" where the student's worksheet based-POE developed is valid and practical. Based on the results of the study, namely the validation

of student's worksheet based-POE to facilitate students' critical thinking skills conducted by six experts, namely physics lecturers FMIPA Universitas Negeri Padang. Validation consists of six components, namely content feasibility, linguistic feasibility, presentation feasibility, graphical feasibility, POE model feasibility, and critical thinking indicators feasibility.

The results of the content validation, consisting of four indicators, yielded a score of 0.80, categorizing it as valid. This confirms that the student's worksheet based-POE conforms to the prescribed guidelines for student's worksheet development. The teaching materials used as a means to support learning activities must contain relevant and appropriate content (Fahlevi et al., 2022). In the second component, linguistic validity, with four indicators, the average score is 0.82, also considered valid, indicating that the language used in the student's worksheet based-POE adheres to good and correct Indonesian language rules. Aspek bahasa yang baik juga berkaitan dengan kesesuaian kalimat dengan tingkat berpikir siswa, kemampuannya, dan kalimat yang tidak memiliki banyak penafsiran (Misbah et al., 2018). The third component, presentation validity, comprising nine indicators, has an average score of 0.80, indicating validity. This suggests that the student's worksheet based-POE follows the planned instructional steps. From these data, it can be concluded that this theaching material is valid for each criterion and the suitability of the material with the competency standards and basic competencies (Rahmatsyah & Dwiningsih, 2021).

The fourth component, graphics validity, which encompasses four indicators, the average score is 0.94, falling within the valid category. This indicates that the student's worksheet based-POE is not only suitable but also visually appealing. The fifth component, the validity of the student's worksheet based-POE, consists of three indicators, with an average score of 0.82, considered valid. This suggests that the POE model's steps and the student's worksheet are compatible. Six indicators make up the sixth and final component, which evaluates the validity of critical thinking indicators. With an average score of 0.79, it is deemed valid. Based on these data, it can be concluded that the LKPD teaching materials are suitable for use as teaching materials to improve critical thinking skills (Yutia & Hasibuan, 2023). Which states that if a teaching material can be declared valid if all of its components meet the minimum valid criteria (Suryanti & Festiyed, 2023). This shows that the overall student worksheet is very valid so the product is suitable for use with minor revisions (Prayogi et al., 2023).

Student's worksheet based-POE comprises instructional materials that promote students' critical thinking abilities, necessitating them to engage in the analysis, synthesis, and evaluation of information to address issues and make informed decisions. This approach emphasizes thinking skills over mere repetition or memorization of content (Peter, 2012). Based on figure 22, which presents students' responses, indicates that students haven't completely grasped the concept, and their critical thinking skills aren't prominently evident. Siswa terlihat sangat antusias untuk berpartisipasi aktif dalam proses pembelajaran dan semua tahapan pada lembar kerja siswa yang telah direncanakan sebelumnya (Asma et al., 2020). However, following the practical exercise and the subsequent student responses depicted in Figure 24, it becomes apparent that students' understanding of the concept and their critical thinking abilities have improved. This improvement in critical thinking is likely a result of the alignment of each stage of the POE model with aspects of critical thinking (Furqani et al., 2018).

Research conducted by Sihombing et al. (2022) states that student worksheets must be designed in such a way as to accommodate the development of the cognitive domain, attitudes, and skills of students so that they are in line with the scientific approach in the 2013 curriculum. Using student's worksheet based-POE offers several advantages, including aiding educators in effectively overseeing the learning process, guiding students in exploring concepts through their activities or collaborative efforts, fostering the development of scientific attitudes, and enabling educators to track students' progress toward achieving educational objectives (Amanda et al., 2022). It is known that positive responses indicate that learning using student worksheets integrated with the POE model on the material of heat temperature and gas kinetic theory is easily understood by students. This is because students find their own knowledge or concepts through a series of experiments (Maghfiroh et al., 2023).

The practicality of the Student Worksheet is determined by students' responses to the developed Student Worksheet, and most of the tasks completed during the learning process (Soenarko et al., 2022). Based on the results of the practicality test research given to teachers, the average score is 98 with a very practical category. In the practicality test conducted, the highest value was obtained in the attractiveness and benefit components with a value of 100%, meaning that the student's worksheet based-POE that has been made is very interesting to use and very useful in the physics learning process. The practicality test conducted on students obtained the highest score on the attractiveness and benefits component with a value of 92%, meaning that the student's worksheet based-

POE that has been made is very interesting and very useful for students in the physics learning process. The responses of teachers and students also showed positive results (Mumtaza & Zulfiani, 2023). Students can answer in groups and discuss in carrying out practicum activities. It can be stated that the student's worksheet has fulfilled the criteria for practicality (Rahmatsyah & Dwiningsih, 2021). This is in line with the results of previous research, which states that if the worksheetbased on critical thinking skills gets an average score in the practical/very practical category, it can beused in the learning process (Hairunnisa et al., 2022; Yutia & Hasibuan, 2023; Suryanti & Festiyed, 2023).

After testing the product, the teacher also gave some comments and suggestions. The teacher commented that the student's worksheet based-POE made was very good and interesting, in the data filling section it was also very easy for students to understand. student's worksheet based-POE that is easy to understand is seen from student responses, the level of readability of student's worksheet based-POE is classified as very good (Cesilia Elwi et al., 2017). This student's worksheet based-POE can help teachers in the learning process and can motivate students to expand their knowledge and explore learning materials to develop their knowledge. Fun learning can attract student involvement, make students delve deeper into learning activities and arouse student motivation so that students enjoy learning and continue learning even outside the classroom (Chen et al., 2020). So, it can be concluded that the student's worksheet based-POE to facilitate students' critical thinking skills is practical and can be used to facilitate students' critical thinking skills on the material of heat temperature and gas kinetic theory.

Conclusion

The results and discussion of this study led to two main conclusions. First, the POE-based student worksheet, designed to improve students' critical thinking skills, showed validity with an average score of 0.82 in the valid category. Second, the practicality of the POE-based LKS evaluated by the teacher falls into the very practical category with an average score of 98% and according to the students' assessment, the practicality score is 90% with a very practical category.

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Author Contributions
This manuscript has been completed with the assistance of all authors. V.E; conducting research, P.D.S; validation of research instruments, H.H; validation of product, and H.H; validation of product.

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Conflicts of Interest
There is no conflict interests.

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