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POE (Predict, Observe, Explain) Model-Based Teaching Materials on Simple Harmonic Motion with a Virtual/Real Laboratory

Badi'atus Sholihah[1*], Sulur [1], Agus Suyudi[1]

[1)]Physics Education, Faculty of Mathematics and Natural Science, State University of Malang, Malang, East Java, Indonesia

E-mail*: *sholihahbadia4@gmail.com*

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ABSTRACT

Referring to the problem of using conventional learning model and teaching material that were less supportive as learning sources, especially in the physics subject, this study aimed to develop POE (Predict, Observe, Explain) model-based teaching materials on simple harmonic motion with a virtual/real laboratory. The type of research used in this study was research and development based on Borg and Gall's framework, which consisted of five steps. The validation subjects consisted of physics lecturers at FMIPA UM, high school physics teachers, and fifteen students from SMA Laboratorium Malang. The research instruments used were an assessment questionnaire and a questionnaire for comments and suggestions. Data analysis techniques used quantitative data by calculating the average and qualitative analysis with suggestions or comments as the result of readability data. The results of validating the student and teacher teaching materials showed a result of 3.62 and 3.63 respectively, indicating that the materials were deemed feasible. The results of readability validation by students indicated that the students agreed that the concept map, material, and sample questions were easy to understand and did not cause double meanings. Therefore, the teaching materials are considered appropriate to be used as learning resources that support student learning and understanding of simple harmonic motion.

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INTRODUCTION

National education is currently still a special concern of the government. The blurry portrait of national education is increasingly complex and difficult to decipher (Kurniawati, 2022). Several causes have been analyzed and refer to curriculum issues as the heart of learning (Ritonga & Basri, 2016). More specifically, the curriculum is a set of plans and arrangements regarding content and learning materials that are used as guidelines for the implementation of teaching and learning activities. This is in line with Hartini, at al. (2018) who said that one of the efforts to create a good learning process is to prepare quality teaching materials.

Quality teaching materials are contextual teaching materials, all activities are student-centered, and can guide students so they can apply them in real life (Budiman, at al., 2021). One of them is in learning physics, which requires students not only to know and memorize but also to master the existing facts. However, until now the teaching materials in circulation still refer to the teacher center with a

conventional learning model. Even though such teaching materials can lead to many misconceptions (Suprapto, 2020).

One of the physics materials that causes many misconceptions is Simple Harmonic Motion (GHS) material. GHS is the alternating motion of an object through its equilibrium point in a straight line. This material is very important to understand considering that there are many applications in life that apply the concept of this material. But the observation results show that students are still confused about the relationship between mass, string length and the pendulum period (Husniyah, et al., 2016). Therefore, students need to be trained to understand concepts and be skilled in solving problems. One way to deal with these problems is to apply an appropriate learning model.

The appropriate learning model to be applied in teaching materials, especially in GHS physics subject matter, is the POE (Predict, Observe, Explain) learning model. The POE learning model was developed for (1) prediction, namely finding students' predictive abilities, (2) observation or observation skills, and (3) explanation, namely, how to explain what they have got (Sarah, S., et al, 2021).

On the other hand, rapid technological advances require teachers to be able to direct students to independently utilize the technology (Suryaningsih & Nurlita, 2021). Thus, making students more independent, creative, innovative, and achieving a complete understanding. One of the technologies that supports students to learn independently is to use a virtual laboratory (Rizal, et al., 2018). So that it is expected that students can actively learn inside and outside of class hours. Therefore, this research develops teaching materials for teachers and students based on the POE learning model on GHS material equipped with virtual laboratory or real laboratory applications presented in video form. In addition, this study also describes the feasibility of the developed teaching materials. So that students can independently study through textbook guides to understand the concept of simple harmonic motion.

METHODS

The type of data used in this research is quantitative and qualitative data. Quantitative data is in the form of the average value of a questionnaire based on a Likert scale, and qualitative data is obtained from comments and suggestions from each validator. The research design used the Borg and Gall research and development design which consisted of ten steps. However, in this study only used five steps due to limited research time, namely (1) research and data collection, (2) planning, (3) product draft development, (4) initial field trials, and (5) revision of trial results. The research steps for developing teaching materials based on the POE learning model with a virtual laboratory or real laboratory on simple harmonic motion material can be seen in Figure 1.

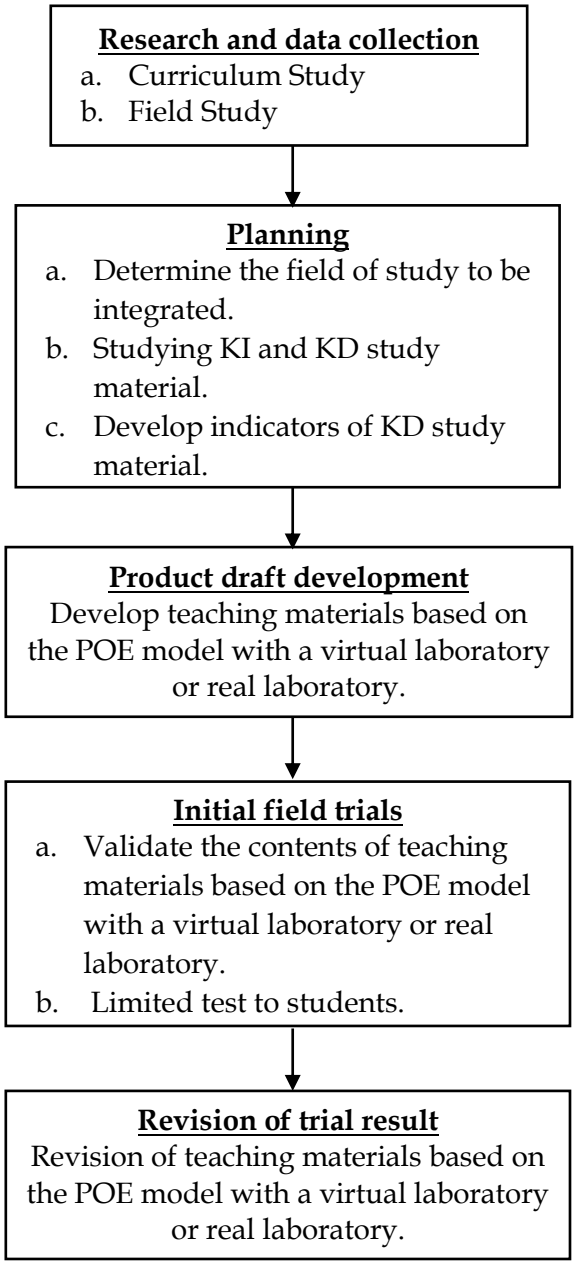


Figure 1. The Research Steps for Developing Teaching Materials

Core competencies (KI) are the main competencies that are broken down into several aspects, namely aspects of attitudes, knowledge, and skills and must be learned by students at every level and subject. While Basic Competence (KD) is several abilities that must be mastered by students in certain subjects as a reference for compiling competency indicators.

The validation subjects were FMIPA UM physics lecturers, high school physics teachers who were experienced in teaching physics lessons, and 15 high school students. The collection of data used in the process of feasibility testing of teaching material products uses an instrument in the form of a questionnaire. The questionnaire used consisted of two parts, namely the first part in the form of an assessment questionnaire and the second part in the form of suggestions and comments. The aspects contained in the assessment of teaching materials include the

front page, table of contents, indicators of learning outcomes, concept maps, indicators of student learning outcomes, content feasibility, content presentation, student activity sheets, summaries, competency test questions, and literature. Assessment questionnaire sheets and suggestions are given to the validator to be validated and given to students to be tested.

The analysis technique uses the calculation of the average value. Based on Arikuntoro (2006: 2016) the formula for calculating the average value is as follows:

$$\overline{X} = \frac{\Sigma x}{n}$$

Where $\overline{X}$ is the average value, Σx is the total score of the assessment answers, and n is the number of validators.

In this assessment, the rating scale used is 1 to 4. The validity criteria of the average analysis used can be seen in Table 1.

Table 1. Criteria for The Validity of The Average Value Analysis

Average	Validation Criteria
3,26-4,00	Eligible/unrevisable
2,51-3,25	Decent enough/no revision
1,76-2,50	Inadequate/partial revision
1,00-1,75	Not worth/total revision

(Adapted from Arikuntoro, 2006)

Qualitative data in the form of comments and suggestions from each validator are used as a consideration in revising teaching materials based on the POE model with the virtual laboratory or real laboratory that has been developed. The analysis technique used to analyze the legibility of the data is the percentage calculation technique. The equation for calculating the percentage is as follows.

$$X = \frac{\Sigma X}{\Sigma X_i} \text{ x } 100\%$$

Where X is the percentage value, ΣX is the score obtained, and ΣX_i is the maximum score.

Furthermore, interpretation and decision-making about the quality of teaching materials are given using the criteria shown in Table 2.

Table 2. Criteria for Readability Test Analysis Results

Rata-rata	Kriteria Validasi
76%-100%	Terbaca
51%-75%	Cukup terbaca
26%-50%	Kurang terbaca
10%-25%	Tidak terbaca

(Adapted from Arikuntoro, 2013:263)

RESULT AND DISCUSSION

The results of this study consist of (1) product design descriptions, and (2) data from design validation and product trials. Design for student teaching materials using the POE model is described in detail as follows.

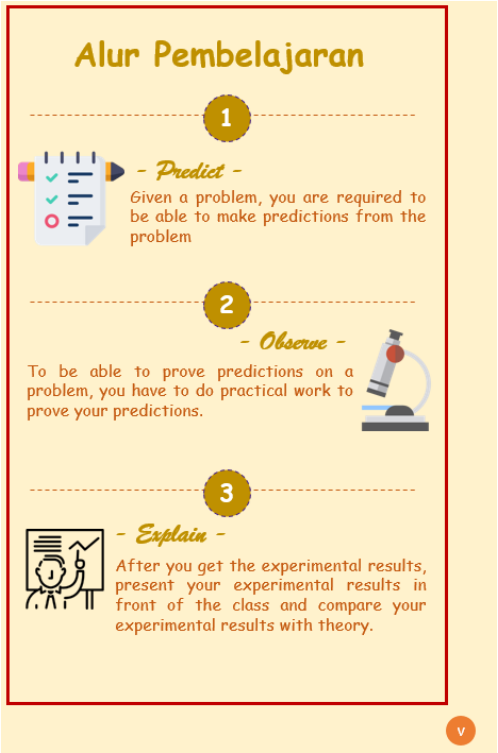
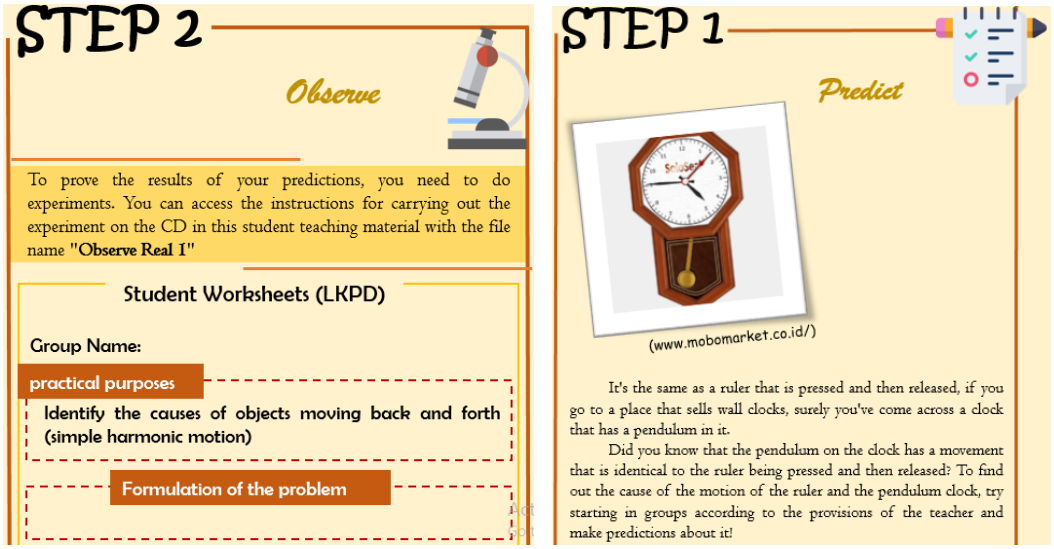


Figure 2. Learning Stages in Teaching Materials That Use The POE Model

The learning stages contain an explanation of the arrangement of teaching materials that follow the POE model. In the learning flow, picture symbols are presented for each stage and a brief explanation of what activities must be carried out.



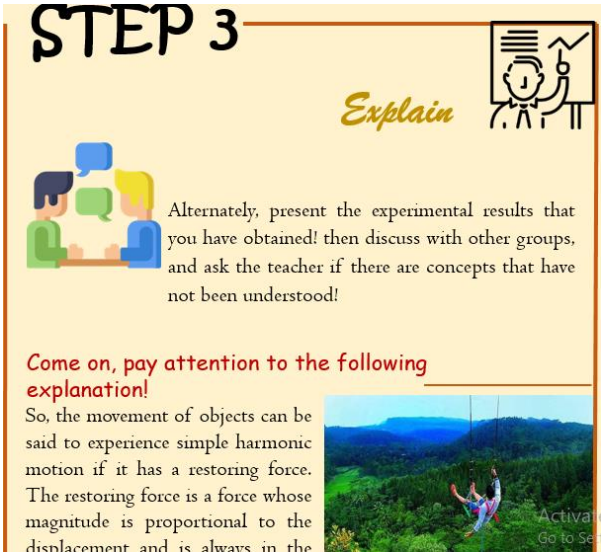
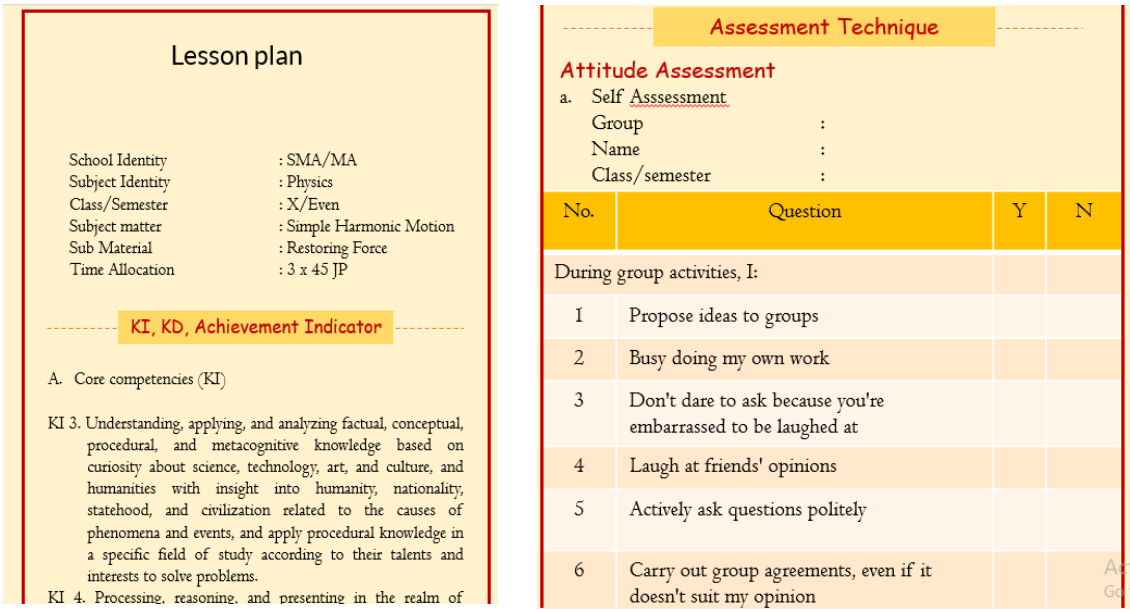


Figure 3. Learning Activities According to The Stages of The POE Model

Learning activities begin with the predict stage. Students make predictions from the problems that have been presented before. Followed by the observe phase which contains experimental activities to prove the prediction results that have been carried out. At this stage, instructions for carrying out experiments using real laboratories are also presented to make it easier for students to carry out experiments independently. Then students can confirm the practicum results through a virtual laboratory, where real laboratories and virtual laboratories are presented on CDs in teaching materials. Virtual laboratories can also be used as a place for independent learning when outside of school. The last stage is explained, at this stage students carry out class discussion activities to communicate the results of the experiments that have been carried out and prove the predictions that have been made. From the stages of the POE model, students will learn independently and contextually so that students get in-depth learning experiences.

Furthermore, the teacher's teaching materials have several additions such as Learning Implementation Plans, assessment techniques, and answer keys as shown in Figure 4.



Lesson plan

School Identity : SMA/MA
Subject Identity : Physics
Class/Semester : X/Even
Subject matter : Simple Harmonic Motion
Sub Material : Restoring Force
Time Allocation : 3 x 45 JP

KI, KD, Achievement Indicator

A. Core competencies (KI)

KI 3. Understanding, applying, and analyzing factual, conceptual, procedural, and metacognitive knowledge based on curiosity about science, technology, art, and culture, and humanities with insight into humanity, nationality, statehood, and civilization related to the causes of phenomena and events, and apply procedural knowledge in a specific field of study according to their talents and interests to solve problems.
KI 4. Processing, reasoning, and presenting in the realm of

Assessment Technique

Attitude Assessment
a. Self Asssessment
Group :
Name :
Class/semester :

No.	Question	Y	N
During group activities, I:			
1	Propose ideas to groups		
2	Busy doing my own work		
3	Don't dare to ask because you're embarrassed to be laughed at		
4	Laugh at friends' opinions		
5	Actively ask questions politely		
6	Carry out group agreements, even if it doesn't suit my opinion		

Figure 4. Learning Implementation Plans and Teacher Material Assessment Techniques

Data validation results of the design of student teaching materials for Simple Harmonic Motion (GHS) materials are divided into teaching material content, constructs of teaching material feasibility of the language used, and suitability of teaching materials with the POE model. Data from the validation results of physics lecturers and physics teachers were calculated using the average analysis technique. The recapitulation of the validation results of student teaching material designs by the validator can be seen in Table 3. Suggestions and criticisms that have been given by the validator are presented in Table 4.

Table 3. Recapitulation of the validation results of student teaching material designs by the validator

Aspect	Restoring force	GHS Period and Frequency	GHS Energy
Content/ Criteria	3,59/ Eligible	3,72/ Eligible	3,83/ Eligible
Construct/Criteria	3,59/ Eligible	3,63/ Eligible	3,48/ Eligible
Language/Criteria	3,56/ Eligible	3,61/ Eligible	3,50/ Eligible
Compatibility of teaching materials with POE/Criteria	3,62/ Eligible	3,67/ Eligible	3,62/ Eligible
Average/Criteria	3,59/ Eligible	3,66/ Eligible	3,61/ Eligible

Table 4. Comments and suggestions for validating the design of teaching materials by the validator.

Aspect	Comments and suggestions
Student activity sheet	Angles are measured above not below don't have to start the vibration at the same time as turning on the stopwatch
Video	The swing should not be a dagger or form a cone Using a spring do not jump up and down

General	$f = 2\pi\sqrt{\frac{k}{m}}$ this equation is not an application in everyday life to motorcycle shockbreakers. It's just a use of a spring related to k (spring constant). This similarity applies to "gamelan tuning", for example. If you want f to go down, then the gamelan (saron) is tuned by being beaten to lower k. if you want f to rise, then it is heated. On a flyover, for example, k and m are set so that resonance does not occur with the frequency of air movement around it. In conclusion, the motorbike shockbreaker is not an application of the equation $f = 2\pi\sqrt{\frac{k}{m}}$

Based on the results of the validation analysis of student teaching materials by the validator in Table 3, it is known that the teaching materials have appropriate criteria. This shows that the teaching materials that have been prepared are in accordance with the criteria of good teaching materials compared to conventional teaching materials that are still widely circulated today. In accordance with Lestari, et al. (2015) the criteria for good teaching materials are teaching materials that can present good content, construct, language and layout and can show responses to students' critical thinking skills. Whereas conventional teaching materials have a language style that is too complicated, does not involve students to actively experiment so it tends to be difficult to understand and creates many misconceptions (Satriawan, et al., 2017).

Furthermore, the recapitulation of the validation results of teacher teaching materials by the validator can be seen in Table 5. The suggestions and criticisms that have been given by the validator are presented in Table 6.

Table 5. Recapitulation of the validation results of teacher teaching materials by the validator

Aspect	Restoring force	GHS Period and Frequency	GHS Energy
Feasibility of Learning Implementation Plans/Criteria	3,64/ Eligible	3,64/ Eligible	3,58/ Eligible
Ease of use of teaching materials / criteria	3,67/ Eligible	3,60/L Eligible	3,60/ Eligible
Average	3,66/ Eligible	3,62/ Eligible	3,59/ Eligible

Tabel 6. Comments and Suggestions for Validating the Eligibility of the Learning Implementation Plans by the Validator

Aspect	Comment and Suggestions
General	There should be a difference between teacher and student videos. In the teacher's video, there are explanations, for example when swinging on a simple swing "make sure the trajectory is straight". And “no need for the stopwatch to run at the same time as starting the swing”.

Based on the results of the validation analysis of teacher teaching materials by the validator in Table 5, it is known that the teaching materials have appropriate criteria. This shows that the teacher's teaching materials which contain lesson plans, assessment techniques, and answer keys are in accordance with the criteria of good teaching materials. Where the preparation of this teacher's teaching materials has been adapted to student teaching materials, namely by making a learning implementation plan that follows the POE model learning steps, so that the learning process and the content in student teaching materials are appropriate. Supported by research conducted by Utami (2018) on teaching materials based on the POE model on material in which the research produced teaching materials with very valid criteria with an average value of 3.7 and has a very good readability level with a percentage value 93.51%.

Furthermore, data from students' readability trials of physics teaching materials based on the POE (Predict, Observe, Explain) model assisted by real laboratory and/or virtual laboratory on GHS material were obtained from 15 class XI students of SMA Laboratorium UM Malang. The data obtained are quantitative and qualitative data. The results showed that students agreed that the concept map, material, and sample questions were easy to understand and did not cause double meanings.

CONCLUSION

The final product of this research is teaching material based on the POE (Predict, Observe, Explain) model with the help of real laboratory and/or virtual laboratory on simple harmonic motion material. The teaching materials are arranged according to the POE model syntax, starting from predict, observe, and finally explain. So, by following the arrangement of the POE model, students can find concepts based on phenomena and observations. In addition, this teaching material is equipped with a CD which contains video instructions for carrying out practicums in real laboratories and virtual laboratories and there is also a video regarding the phenomena presented in the apperception of teaching materials. After the product has been developed, it is then validated by a validator consisting of one UM physics lecturer and two high school teachers to determine the feasibility or validity of the teaching materials. The results of the validation show that the teaching materials have appropriate criteria. The results of the readability test of teaching materials on 15 class XI SMA Laboratorium UM showed that the level of readability of students towards teaching materials was good. So, this research supports students learning to understand simple harmonic motion independently and contextually so that students get in-depth learning experiences. Therefore, the follow-up of this research is to develop POE-based teaching materials with virtual/real laboratory on crucial material in physics lessons.

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