The development of students worksheet based on Predict, Observe, Explain (POE) to improve students’ science process skill in SMA Muhammadiyah Imogiri

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Abstract. This study aims to: 1) obtain the appropriate product of physics Worksheet based on POE, 2) determine the students’ performance using POE-based Worksheet to improve the scientific process skill. This research is Research and Development (R & D). The development conducted by referring to the 4-D model (Define, Design, Develop and Disseminate). The subject of this study is the students of SMA Muhammadiyah Imogiri Yogyakarta. The total number of students is 42, 10 students belong to the small group test, 32 students belong to field test. The instruments of the research a questionnaire, test (post-test), and the distribution of student responses on the Worksheet. The results of this study were 1) the development results of physics POE-based Worksheet was feasible by the experts validation based on the content, language, presentation, and good validity graphic; 2) the percentage of learners' success in implementing the skills of the scientific process in the formulating hypotheses (83.1%), choose tools and materials (83.1%), writing experimental data (68.8%), analysing data (72.1%), interpreting data (77.1%) and make conclusions (91.4%). Based on the percentage of students achievement, the result on pre-test 36.5% (not good) and post-test 72.0% (quite good), the results able to be calculated the improvement of students’ achievement competencies using N-Gain technique 0.6 which included in the middle category. Based on this result, the developed Worksheet had a decent usage.

1. Introduction
Improving the quality of education is an integrated process with the process of improving the quality of human resources because the role of education and the level of the human development is the dominant factor in the human ability to deal with the problems of everyday life [1]. Learning is a deliberate effort made by educators to deliver knowledge, organize and create environmental systems with various methods so that students can do learning activities effectively and efficiently and with optimal results [2]. The physics learning process must involve students actively in physics learning, students must learn to get their own physics. So, students must be involved in learning activities. Early observations made in class X Muhammadiyah Imogiri high school showed that the teaching and learning process of physics subjects, the teacher only guided the existing learning tools. So it still seems monotonous with lectures and only demonstrates a few examples of tools in front of the class. The teacher records several important things about the material being delivered, so that students only listen to the teacher who explains in front of the class and there are some students who record important things that have been recorded by the teacher on the board. In physics learning, the
experience of science processes and understanding of scientific products in the form of direct experience will be very meaningful in shaping students' concepts.

Science process skills are procedural skills, experimental skills and investigating or scientific abilities [3]. Merging several mental processes in science, especially in laboratory work is referred to as science process skills which include observing, classifying, using a scale or time relationship, calculating, measuring, creating trends or patterns, predicting, making operational definitions, formulating models, controlling variables, interpreting data, and conduct experiments [4].

The word science or science is seen from the point of language as coming from Latin, that is from the word *Scientia* which means knowledge of, or know about; knowledge, understanding, true and deep understanding [5]. Science as a collection of knowledge obtained by using methods based on the careful observation [6]. Science as a series of concepts and conceptual schemes that relate to each other, and which grow as a result of experimentation [7]. Science process skills are intellectual skills possessed and used by scientists in researching natural phenomena [16]. The science process skills used by these scientists can be learned by students in a simpler form in accordance with the stage of child development. In other words, science process skills are both cognitive and psychomotor intellectual and scientific skills for researching and conducting scientific investigations. The Scientific inquiry carried out by students in learning activities is to understand the material that adopts a scientific approach including observing, questioning, analyzing, concluding, and communicating. Observations, as well as useful to observe and experiment further.

In an effort to maximize the learning process of physics, teachers need to make innovations in learning in accordance with the learning objectives to be achieved. In physics learning, the teacher must carry out exploration and experiment activities to achieve the learning objectives [15]. It is intended that the learning process of physics is not boring, not scary, full of formulas and calculations and can make students enjoy learning physics because students feel they can understand the relationship between what is learned with the natural problems they see in everyday life. It can also facilitate the formation of physics concepts in students more easily and better. In addition, the use of appropriate and varied learning models can be an instrument of extrinsic motivation in teaching and learning activities. So, so that the goal of physics learning can be achieved, the right learning model is needed, which is a learning model that is not only focused on students but is motivated by students. The role of students who are active in learning is expected to attract students' enthusiasm to learn physics. One learning model that can be used in physics learning is a POE learning model.

POE (predict, observe, and explain) uses three main steps of the scientific method, the first is predict or make predictions, making predictions or guesses is the first step in POE learning [15]. The teacher gives a physics problem to students, then students formulate the allegations based on the problem. Students are given the broadest freedom in providing predictions, students must also prepare the reasons for the predictions they provide based on the physics concepts that have been mastered before. In this step, the teacher can find out how much students understand the physical concepts being taught [8] [15].

Furthermore, for the second stage, observe at this stage students make observations about what is happening, students are invited to experiment, observe, or take measurements. The main purpose of observing is to find out the answers to the predictions given by students. In this step, the teacher can find out the ability of students in preparing tools and materials and use according to the steps of the experiment that should be. Then in the third step, explain the suitability of the predictions (predictions) with facts (observations). The final step is to make an explanation, students are given the opportunity to explain the results of observations and their suitability with the initial predictions. If the prediction is correct, then the student will be sure of the concept. However, if the student's prediction is not correct then the teacher will help students in finding explanations. Thus students will find the true concept of the physical problem being studied.
2. Experimental Methods
This study uses a design and development research approach (Research and Develop / R & D) or is included in development research. In this study developed a Student Worksheet based on POE (Predict, Observe, Explain) to improve students' science process skills. The development of this worksheet refers to the development of a 4-D model (Four D Model) proposed by Thiagarajan. This model consists of 4 stages of development, namely Define, Design, Develop, and Disseminate or adapted to the 4-P Model, namely Defining, Designing, Developing and Spreading [9]. The data in this study will be analyzed qualitatively and quantitatively, qualitative data on science process skills were obtained using non-test techniques, in the form of observation. While quantitative data is obtained using test techniques. As for analyzing it can be done in the following way. Qualitative data analysis techniques by changing the value in the qualitative form using a scale of five [10]. The score step calculated value then look for the average score, then the average score is converted to a scale as in Table 1 as follows.

| Value | Score interval | Category      |
|-------|----------------|---------------|
| A     | $X > X_i + 1.80 SB_i$ | Very Good    |
| B     | $X_i + 0.60 X_i < X \leq X_i + 1.80 SB_i$ | Good         |
| C     | $X_i - 0.60 SB_i < X \leq X_i + 0.60 SB_i$ | Enough       |
| D     | $X_i - 0.60 SB_i < X \leq X_i - 0.60 SB_i$ | Less         |
| E     | $X \leq X_i - 1.80 SB_i$ | Very Less    |

Explanation:
$X_i$ = Average ideal score = $\frac{1}{2}$ (ideal maximum score + minimum score ideal).
$SB_i$ = Ideal standard deviation = $\frac{1}{6}$ (ideal maximum score - ideal minimum score).
$X$ = Actual Score.

Analysis of competence improvement that occurs before and after learning using worksheet is calculated by the equation $g$ factor (N-Gain) as follows:

$$g = \frac{Skor \ Posttest - Skor \ Pretest}{Skor \ Ideal - Skor \ Pretest}$$  \hspace{1cm} (1)

Then the N-Gain interpretation is presented in Table 2 as follows [11].

| No | Big Percentage | Interpretation |
|----|----------------|----------------|
| 1  | $g > 0.7$      | High           |
| 2  | $0.3 < g < 0.7$| Medium         |
| 3  | $g < 0.3$      | Low            |

3. Results and Discussion

3.1. The Development of Students Worksheet Based on POE
The results of the validation of the POE-based physics Worksheet that has been carried out on the feasibility aspects of the validator content state that the worksheet is oriented to very good quality laboratory work. The developed worksheets can measure students' science process skills in form of hypotheses, determining tools and materials, writing experimental data, data analyzing, interpreting data, and making conclusions. In linguistic aspects, the language used in accordance with the level of
cognitive development of students the sentences used in Worksheet are simple, clear, and easy to understand. Furthermore, the aspect of the presentation, Worksheet encourages students to do creative work because in the worksheet the development results are equipped with pictures and illustrations, and the last aspect of graphics used to attract the attention of worksheet students from the development can attract reading interest for students and create a pleasant atmosphere.

Based on the assessment that has been done shows that the validator states that physics worksheet is based on POE (Predict, Observe, Explain) oriented to good quality laboratory work. The developed worksheets can be used by students to actively participate in the physics learning process in the material laboratory in a worksheet that is developed in accordance with the 2013 curriculum and the selection of tools used in each activity in accordance with the learning material.

Achievement of students' physical process skills while participating in learning using developed worksheets. The worksheet product trial was carried out with a view to measuring students' initial physical process skills. The process skills observed are integrated skills in the scientific process which includes the skills to construct hypotheses, choose tools and materials, write experimental data, data analyze, interpret data, and make conclusions [16] [17].

3.2. Student Science Process Skill

![Figure 1. Small Group Test Results](image1)

Data on science process skills were obtained from observation, in Figure 1 shows that a small group trial consisted of 10 students. The indicators compile hypotheses 68.3%, choose tools and materials 79.1%, write experimental data 70.8%, data analysis 62.5%, data interpretation 72.5% and conclusions 79.1%. From the observation results show the lowest percentage of data analysis indicators while choosing the highest percentage of tools and materials.

![Figure 2. Large Group Test Results](image2)
Data on science process skills were obtained from observation, in Figure 2 shows that the large group trial consisted of 32 students. The indicators compile hypotheses 83.1%, choose tools and materials 83.1%, write experimental data 68.8%, data analysis 72.1%, data interpretation 77.1% and conclusions 91.4%. From the observations, the indicator writing experimental data has the lowest percentage while making the conclusion has the highest percentage. Based on the results of data analysis in Figures 1 and 2 shows that science process skills can be improved by using POE-based worksheets. In addition to using POE-based worksheets, science process skills can also be improved using practicum [13]. Improving the achievement of science process skills proves that POE-based physics worksheets oriented to laboratory work can improve students' science process skills. Science process skills are related to academic skills, which are often called intellectual skills or scientific thinking skills [14]. This skill consists of composing hypotheses, selecting tools and materials, writing experimental data, analyzing data, interpreting data, and providing conclusions.

Based on the results of students' science process skills, this proves that the worksheets that researchers develop can be used to improve students' science process skills, especially the skills to construct hypotheses, determine tools and materials, write experimental data, analyze data, interpret data, and make conclusions. But this worksheet is not perfect, because there are still students who complain about worksheets oriented to laboratory work that the researchers developed. Worksheets developed can help in active learning and help connect science and technology with everyday life. Worksheets developed can help understand the concept of physics, help conduct experimental procedures, facilitate observing physical symptoms in experiments, and can help provide direct experience in the implementation of teaching and learning processes and be able to develop students' physical process skills.

The development of worksheets with a laboratory work approach as an active learning method that requires students to be involved in observing or manipulating real objects and materials has a special and central role to develop students' understanding of scientific concepts, improve cognitive skills and develop positive attitudes. Laboratory work can give students the opportunity to engage in the authentic scientific practice, develop technical, laboratory skills, and engage collaboratively with others in designing and building experiments, collecting and interpreting data, and communicating scientific content [12].

Competency improvement analysis that occurs before and after learning using worksheets is calculated by the equation $g$ factor (N-Gain). Calculation results are presented in Table 3.

| Criteria     | Average Pretest | Average Posttest | Standard Gain (g) | Criteria |
|--------------|-----------------|------------------|-------------------|----------|
| Medium       | 36.5            | 72.0             | 0.6               | Medium   |

From Table 3 it can be seen that the relationship between pretest and posttest values using the gain-test is 0.6 with the criteria being Medium.

4. Conclusion
Worksheet based physics based on feasible development based on validation from the expert on feasibility aspects of content, language, presentation, and graphics have good validity; Based on the validation of the expert aspects of the content feasibility, language, presentation, and graphics entered in both categories and is considered to have good content validity, so worksheet based physics POE development results worthy of use in physics learning high school students class X percentage of students achievement in mastering the science process skill based on POE physics based physics score of ability in preparing hypothesis (83.1%), choose tools and materials (83.1%), writing experiment data (68.8%), data analyze (72.1%), interpret data (77.1%), and make conclusion (91.4%). Based on this case, the worksheet developed good achievement. improvement of cognitive learning outcomes of
students based on pretest and posttest work with N-Gain technique of 0.6 included in the medium category.

5. References

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