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The Effectiveness of POE Learning Model-Based Student Worksheet to Improve Students' Science Process Skills

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ABSTRACT

This study aims to analyze the effectiveness of student worksheet (SWS) based on the Prediction, Observation, Explanation (POE) learning model on increasing student Science Process Skills (SPS). The research method used is quasi-experimental with a non-equivalent control group design. The selection of research samples was conducted using a cluster random sampling technique from the population of students of class XI SMAN 2 Painan for the 2021-2022 school year so that class XI MIPA1 and XI MIPA 2 were obtained as samples. The data analysis technique is carried out by quantitatively analyzing the results of observation of the attitudes and skills of students. At the same time, the knowledge aspect uses a two-average comparison test. The results showed that in the attitude aspect, 91.67% of students were in the competence of attitudes A and B. The knowledge aspect showed a difference in the average SPS of experimental class students and control classes with a t count of 5,779, while the t table was 1,994 (tcount > ttable). Meanwhile, in the skill aspect, 91.67% is above the minimum completeness criteria. It is concluded that SWS, based on the POE model, can improve the SPS of students in terms of attitudes, knowledge, and skills effectively.

INTRODUCTION

The era of the industrial revolution 4.0 was marked by increasingly rapid and advanced developments in science and technology (Amelia et al., 2021). This development is a challenge for the world of education. Productive human resources with the competence and skills ready to compete in the globalization era are needed to answer the challenges of the world of education (Amelia et al., 2021). Therefore, learning must prepare students to learn independently, be active, develop their reasoning and thinking abilities, and master various skills (Paoliana et al., 2020). Besides that, the learning must foster students' mastery of competencies, including collaboration, communication, creativity, character, literacy, and critical thinking (Asrizal et al., 2018).

Student-centred learning is needed to make that happen. Teachers are required to develop creativity by conditioning a conducive learning environment and challenging

students' curiosity. Classroom learning must be able to develop knowledge, skills, and attitudes. These three aspects of student competence are built into the core activities (Hendri et al., 2018). The skills competence aspect requires students to demonstrate the skills of reasoning, processing, and presenting effectively, creatively, productively, critically, and scientifically independently (Supeno et al., 2017). These three aspects of competence are also the objectives of learning physics.

Physics is the basis for various advances in science and technology today. Physics is part of science, with nature as a process, product, and attitude(Sarah et al., 2021). The nature of this science demands that science learning is not only in the form of knowledge transfer but a constructivist process that facilitates students to practice skills, build their cognitive abilities, and foster a positive attitude. (Asrizal et al., 2018). Thus, the objectives of learning physics and aspects of knowledge also include aspects of attitudes and skills.

Science process skills are very important for students in the learning process because they can make students more creative and think logically in solving problems. *Science process skills* (SPS) are used to create information, think about a problem, and formulate how to solve the problem(Wayan Darmadi et al., 2014). SPS is a skill needed to acquire, develop, and apply concepts, principles, laws, and scientific theories, whether in the form of mental skills, physical (manual) skills, or social skills (Rahayu et al., 2015).

SPS involves not only aspects of skills but also cognitive and intellectual aspects (Nofita Sari & Azwar, 2017). Several reasons students must have SPS include: (1) science, especially physics, consists of three aspects, namely processes, products, and attitudes; (2) physical science changes along with the times; (3) students will better understand complex and abstract concepts if accompanied by concrete examples; (4) students will have an understanding of the subject matter and encourage them to be more active in the learning process (Wayan Darmadi et al., 2014). In line with this, SPS is needed in understanding any phenomenon because SPS is needed to obtain, develop and apply concepts, legal principles, and theories(Amnie et al., 2014).

SPS encourages students to process new information through real experiences (Nuraini& Waluyo, 2021). Therefore, SPS students can develop well if learning presents concrete experiences such as practicum activities. Practicum activities allow students to experience themselves, seek the truth, try to find a law or proposition, and draw conclusions about the process they are experiencing (Djamarah, 2005; Setiawan, 2012). Practicum activities carried out by students well can improve SPS and the scientific attitudes of students (Asrizal, et al., 2018; Wahyudi, 2018).

The reality on the ground does not reflect the expected conditions. After the SPS test was carried out for class XI MIPA1 students at SMAN 2 Painan, it was found that the students' SPS was still low. Students' SPS classical mastery was only 33%, with an average of 62.97, as shown in Table 1.

Table 1. Science Process Skills Value of Class XI MIPA1 Students of SMA Negeri 2 Painan Semester II TP 2021/2022

Description	Class XI MIPA1
Highest	85
Lowest	40
Standard Deviation	14.30
Classical Mastery (%)	33
Average	62.97

Based on an analysis of the results of interviews with several physics teachers at SMAN 2 Painan on August 23, 2021, there are four causes for the low SPS of students. First, learning still applies to the teacher centre. Second, the lesson plan prepared by the teacher needs to

contain a learning model. The three SWS prepared by the teacher were not by a good SWSstructure and needed to follow the syntax of the learning model.

SWS is very useful in maximizing students' understanding to develop basic abilities according to achievement indicators of learning outcomes that must be taken. Purwanti (2021) states that the functions of using SWS are: 1) activate students in learning, 2) helping students develop and instil concepts based on descriptions of observations and data obtained in experimental activities, 3) train students to develop SPS, 4) train students to obtain material learned through activities carried out at school, 5) helping teachers arrange or plan learning activities, including selecting approaches and methods, learning motivation, selecting media, and evaluating learning, and 6) helping teachers prepare to learn activities appropriately because the SWS that has been made can be used again in the following school year. Thus, using SWS stimulates students to be active in learning because they feel they are responsible for completing their learning assignments. In learning physics, SWS is used as a guide for students in carrying out investigative or problem-solving activities to discover new concepts and knowledge (Cesilia Elwi et al., 2017).

SPS students can be influenced by the selection of learning models that are relevant, effective, and efficient to apply. One learning model that can emphasize student SWS is the POE (Prediction, Observation, Explanation) learning model (Nugraha et al., 2019). The POE learning model stimulates students to be more creative in proposing predictions, conducting experiments to test predictions, and comparing conjectures with reality (Yupani et al., 2013). The POE model is a learning model that begins by confronting students with problems. Students predict solutions to problems (Predict), then make observations to prove predictions (Observe), and explain the results of their observations (Explain) (Septy et al., 2017). One of the advantages of the POE learning model is that it can train students' SPS because students are directly involved in discovering a concept or a learning process skill (Linda Nurmalasari et al., 2016).

Research conducted by Pane et al. (2020) showed that applying the POE learning model significance affects students' SPS, with an effect size of 0.71 in the high category. The weakness of this study is that the supporting data to prove the effect size obtained needs to be presented. In addition, the SPS assessment in this study is still in the form of questions to find out the achievement of the knowledge aspect, while the attitude and skills aspects still need to be visible. The researchers added that POE learning is not always easy to implement; managing a class during exploration causes students to often underestimate and depend on their peers and causes difficulties in monitoring student activity. The difficulties that the researchers stated in this study and the solution to overcome them is the need to develop learning tools in implementing the POE learning model.

In addition, Hidayah and Yuberti's research (2018) also shows that students' SPS increases by applying the POE learning model with an effect size of 1.20 in the very high category. The weakness of this study is that the SPS assessment still assesses the knowledge aspect of SPS, while the attitude and skill aspects still need to be visible. In addition to the knowledge aspect through the test instrument, attitudes and skills should be assessed using non-test instruments.

Based on some research results, students' SPS increases by applying the POE model in physics learning. As described above, some of these studies still need to improve their implementation. Among the limitations of this research is that it has just tested the effectiveness of applying the POE learning model to SPS students in the knowledge aspect, while the attitude and skill aspects have not been seen (Pane et al., 2020; Zulaiha et al., 2014). In addition, the teacher had difficulties managing the class at the explanation stage and organizing class and time (Amelia et al., 2021).

The authors' solution in this study is the development of SWS based on the POE model to improve students' SPS. The advantage of the solutions offered is that this research develops valid and practical worksheets so that the POE learning model syntax activities can be carried out properly. The effectiveness that will be analyzed in this study is the SPS of students in knowledge, attitudes, and skills. Therefore, research has been carried out to develop worksheets based on the POE learning model to improve student SPS which are valid, practical, and effective in their use.

METHODS

The method used in this study is quasi-experimental. The population in this study were students in class XI MIPA for the 2021-2022 academic year at SMAN 2 Painan. The sampling technique used was random cluster sampling, namely tests for normality, homogeneity, and average population similarity using the previous material Physics daily test scores. Then two classes were selected with normal data, homogeneous variances, and the same mean as the sample. Class XI MIPA 1 was selected as the experimental class, and class XI MIPA 2 as the control class. The experimental class was given different learning by utilizing the SWS based on the POE learning model, while the control group was not. The form of the quasi-experimental design used is the Non-equivalent Control Group Design, as shown in Table 2 below.

Table 2. Research Design

Class	Treatment	Final Test
Experiment	X	T
Control		T

The effectiveness of SWS is seen in students' attitudes, knowledge, and skills, so the SWS effectiveness instruments consist of attitude assessment instruments, SPS-based knowledge tests, and skills assessment instruments in the form of SPS. Before being used, these three assessment instruments were first assessed by three experts to test their validity. Furthermore, the SPS-based knowledge test was tested first in class XI MIPA.3 SMAN 3 Painan, and then its reliability was analyzed.

Data analysis techniques for the effectiveness of SWS on the attitude aspect use the equation:

$$value = \frac{score\ obtained}{maximum\ score}\ x\ 100\ \%$$

The competency category of students' attitudes toward the minimum completeness criteria at SMAN 2 Painan, namely 78, can be seen in Table 3.

Table 3. Attitude Competency Categories of Learners Score Obtained

MCC	Predicate			
78	D =Not enough	C =Enough	B = Good	A = Very Good
	<78	78-84	85-92	93-100

(Source : Permendikbud No. 53 Tahun 2015)

The effectiveness of SWS is achieved in the attitude aspect when 90% of students have achieved an attitude value at the predicate A or B. Then, for analyzing aspects of students' knowledge, the normality and homogeneity tests were first carried out for the two sample classes. Furthermore, a comparison test of two means was carried out as a t-test. The effectiveness of SWS is achieved in the knowledge aspect when there are differences in the

knowledge competence of the experimental class and the control class statistically with the condition t-table t-count table. Analysis of aspects of student skills (SPS) using the equation:

$$N = \frac{X}{JM} \times 100\%$$

Where N is the percentage of students' SPS, X is the total score obtained by students, and JM is the maximum total score. Then the SPS category of students for MCC at SMAN 2 Painan, namely 78, can be seen in Table 4.

Table 4. Skills Competency Categories of Learners

MCC	Predicate			
	D = Not	C =	B = Good	A = Very Good
78	Enough	Enough		
	<78	78-84	85-92	93-100

(Source :Permendikbud No. 53 Tahun 2015)

The effectiveness of the product being developed is achieved in the skill aspect if 90% of students have achieved a skill score at A or B predicate.

RESULTS AND DISCUSSION

The effectiveness of SWS can be seen from the SPS achievement of students in the aspects of attitude, knowledge, and skills. The assessment was carried out five times in class XI MIPA.1 SMAN 2 Painan on the subject of running waves and stationary waves. Student SPS attitude aspect is carried out every meeting by one observer through student attitude assessment sheets. This assessment is carried out to see the increase in spiritual and social attitudes during the learning process. Attitude assessment indicators include; curiosity, conscientiousness, cooperation, and responsibility. The results of observations on student attitudes can be briefly seen in Table 5.

Table 5. Recapitulation of Student Attitude Competency Assessment Results

No	Attitude Aspect	Meeting Value (%) I	II	III	IV	V	Average	Criteria
1	Curiosity	95.83	93.06	88.89	93.75	95.14	93.33	Very Good
2	Thorough	94.44	95.14	90.97	92.36	90.97	92.78	Good
3	Cooperation	94.44	93.75	83.33	94.44	91.67	91.53	Good
4	Responsibility	92.36	90.97	90.28	93.06	90.28	91.39	Good

Table 5 shows that the attitudes of students are in a good category. A very good attitude is curiosity. It shows that the POE model SWS can increase students' curiosity about Physics subject matter. A careful attitude of cooperation and responsibility is in good criterion. It shows that the POE model SWS stimulates students to be thorough, responsible, and cooperative in obtaining, analyzing, and interpreting data during running and stationary wave experiments. Students' attitudes in using the POE model SWS improved during the learning process. It is influenced by learning using the POE model to make students more interested and motivated to learn (Permatasari & Marwoto, 2017). Using the POE model makes students enthusiastic, active, and creative in understanding physics learning (Mega Samudera et al., 2017). The recapitulation of student attitude competencies can be seen in Table 6.

Table 6. Recapitulation of Student Attitude Competency

Attitude Value	Predicate	Total Number of Students (people)
<78	Not enough	0
78-84	Enough	3
85-92	Good	11
93-100	Very good	22

Table 6 shows that 33 students out of 36 people are in the attitude predicate A and B, meaning that 91.67% of students are in the attitude competencies A and B. Based on this, the SWS using the POE model that has been developed is in the effective category. It can increase the competence of students' attitudes in the form of curiosity, conscientiousness, cooperation, and responsibility.

The effectiveness of SWS is measured from the knowledge competency carried out sequentially, starting from the difference in the mean of the experimental and control classes, the normality test, the homogeneity test, and the comparison test of the two independent groups. From the SPS test score data, calculations were made for statistical parameters such as the average score, standard deviation, and variance of the experimental and control classes, as shown in Table 7.

Table 7. Knowledge Competency Value of Control and Experiment Classes

No	Statistical Parameters	Control Class Value	Experiment Class Value
1	Average	68.00	82.44
2	Standard deviation	10.85	10.31
3	Variance	117.77	106.20
4	Lowest value	52.00	60.00
5	The highest score	86.00	100.00
6	Median	68.00	84.00
7	mode	80.00	91.00
8	Value Range	34.00	40.00

Based on Table 7, the average value of SPS knowledge competence of students in the experimental class is higher than the control class. The mean value of the SPS test for the experimental class was 82.44, while that for the control class was 68.00. A comparison test was carried out between two independent groups to see if there were differences in the average SPS test scores for the experimental and control classes statistically. The requirement to carry out a comparison test of two independent groups is first to carry out a normality test and a homogeneity test. After carrying out the normality test, the data is obtained in Table 8.

Table 8. Results of Normality Test for Experimental and Control classes

Class	Real Level	L_t	L_0	Distribution
Experiment	0.05	0.1477	0.0973	Normal
Control	0.05	0.1477	0.1438	Normal

From the data obtained in Table 7, it turns out $L_o < L_t$. So, it can be said that the experimental and control classes are normally distributed. Then the homogeneity test was obtained F_{count} = 1,1090 dan F_{table} in dk quantifier 35, dk denominator 35 adalah 1,765. The results obtained by $F_{count} < F_{table}$. So, it can be concluded that the two classes have a homogeneous variance.

After carrying out the normality and homogeneity tests, it was found that the data in both classes were normally distributed, and the two classes had a homogeneous variance. So

to test that there is a difference in the average value of SPS knowledge in the experimental and control classes, the t-test is used. The hypothesis used is Ho = No difference in the SPS knowledge competence of the experimental and control classes, and Hi = There is a difference in the SPS knowledge competency in the experimental and control classes. The test criterion is to accept Ho if($-t_{1-1/2\alpha} < t < t_{1-1/2\alpha}$) with dk = n_1+n_2-2. The results of the calculation of the comparison test of the two independent groups are presented in Table 9.

Table 9. Comparison Test Results of Two Independent Groups

Real Level	dk	t_{count}	t_{table}	Distribution
0.05	70	5.799	1.9944	Hi Accepted

Table 8 shows that the value of count is outside the acceptance area of Ho, meaning that there are differences in the SPS knowledge competence of the experimental class and the control class at the 95% confidence level. It means that SWS uses the POE model that has been developed to improve students' SPS knowledge competencies effectively. It is because SWS uses the POE model to help students think more actively and feel challenged during learning, especially in proving a concept based on the results of their observations and analysis (Hidayah et al., 2018). The results of this study are also in line with the research of Nurbaiti et (2020), which stated that the results of the concept mastery test in the experimental class were higher than the control class.

Furthermore, the effectiveness of using SWS was also obtained from the results of observations on the skills of students while participating in learning on running wave and stationary wave material. The skills assessment for five meetings consisted of ten SPS indicators. The ten SPS indicators are observing (M1), differentiating (M2), identifying variables (M3), formulating hypotheses (M4), carrying out practicum (M5), measuring (M6), obtaining and processing data (M7), interpreting (M8), apply the concept (M9) and communicate (M10). Data from observations of student skill competencies by observers can be briefly seen in Table 10.

Table 10. Results of Student Skills Data Analysis

No	Aspect	Meeting Value (%)					
		I	II	III	IV	V.	Average
1	Observing (M1)	89.67	92.59	91.67	92.59	91.67	91.64
2	Differentiate (M2	91.67	89.81	91.67	88.89	91.67	90.74
3	Identify variables (M3)	90.74	90.74	93.52	90.74	91.67	91.48
4	Formulate a hypothesis (M4)	91.67	87.96	88.89	89.81	87.04	89.07
5	Carry out practicum (M5)	88.89	91.67	88.89	91.67	90.74	90.37
6	Gauge (M6),	93.52	91.67	91.67	94.44	89.81	92.22
7	Obtaining and processing data (M7),	89.81	88.89	89.81	91.67	90.74	90.19
8	Interpret (M8),	90.74	91.67	76.85	81.48	93.52	86.85
9	Applying the concept (M9)	95.37	86.11	79.63	75.93	93.52	86.11
10	Communicate (M10).	94.44	93.52	94.44	95.37	94.44	94.44
	Average	91.65	90.46	88.70	89.27	91.48	90.31

Table 9 shows the average score of students' competency skills is 90.31 with the predicate B (Good), and 91.67% of students score above the MCC with the predicates A and B. It means that SWS uses the POE model in learning class XI is effective in its implementation and improves students' SPS in the learning process. It is because SWS makes students' SPS visible using the developed POE model and increases according to the indicators assessed. The POE model SWS can develop student learning activities, including making predictions, making observations or experiments to prove predictions, and conducting discussions to find their

understanding of the material being taught by critically analyzing the results of observations and predictions made (Septy et al., 2017). The POE learning model stimulates students to be creative and enthusiastic about experiments, directly observing events and comparing conjectures with reality (Rozana et al., 2018).

Overall, 91.67% of students who used the developed SWS scored above the MCC with A and B predicates in attitudes and skill competencies. Whereas in the knowledge competency, there is a significant difference between classes using POE-based SWS and classes that do not use POE-based SWS. It shows that the SWS based on the POE model is effectively used in learning Physics to improve students' SPS.

CONCLUSION

The study results were seen from the SPS achievement of students in the aspects of attitude, knowledge, and skills. The effectiveness of the POE model-based SWS is achieved in the attitude and skill aspects. Regarding knowledge, there is also a significant difference in students' SPS between the experimental and control classes. It shows that students' SPS can be improved by using POE-based SWS. Based on these results, the SWS based on the POE learning model effectively improves students' SPS in attitude, knowledge, and skills. POE-based SWS can not only be applied at the SMA/SMK level but can also be applied at the elementary and junior high school levels. However, the process must refer to research and development procedures to obtain better worksheets for the learning process. The hope for future research is that the results of this study can be used as a reference and basis for conducting further research.

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