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The Effectiveness of Predict, Observe, Explain (POE) Based Modules on Learning Outcomes on Solubility and Solubility Products Materials

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Abstract: The Effectiveness of Predict, Observe, Explain (POE) Based Modules on Learning Outcomes on Solubility and Solubility Products Materials. This study aims to determine the effectiveness of using the Predict, Observe, Explain (POE) based chemistry module on student learning outcomes. The research method used was true experiment with a pretest-posttest control group design. The sample in this study were students of class XI MIPA SMA N 1 Simo, SMA N 1 Teras, and SMA N 1 Banyudono, which was carried out using purposive sampling technique. Data analysis was performed using SPSS 16.0 for Windows with paired sample t-test technique. These results indicate a significant difference in the mean learning outcomes between the experimental class and the control class in all three schools, so it can be concluded that the Predict, Observe, Explain (POE) based chemistry module on the solubility material and the solubility product is effective for improving student learning outcomes.

Keywords: predict, observe, explain (POE), solubility and solubility products, learning outcomes

Abstrak: Efektivitas Modul Berbasis Predict, Observe, Explain (POE) terhadap Hasil Belajar pada Materi Kelarutan dan Hasil Kali Kelarutan. Penelitian ini bertujuan untuk menentukan efektivitas penggunaan modul kimia berbasis Predict, Observe, Explain (POE) terhadap hasil belajar siswa. Metode penelitian yang digunakan adalah true experiment dengan desain Pretest-Posttest Control Group. Pengambilan sampel dilakukan dengan teknik purposive sampling. Analisis data dilakukan dengan bantuan SPSS 16.0 for Windows dengan teknik uji-t dua sampel berpasangan (paired sample t-test). Hasil penelitian menunjukkan adanya perbedaan rata-rata hasil belajar yang signifikan antara kelas eksperimen dan kelas kontrol. Berdasarkan hasil penelitian dapat disimpulkan bahwa modul kimia berbasis Predict, Observe, Explain (POE) pada materi kelarutan dan hasil kali kelarutan efektif untuk meningkatkan hasil belajar siswa.

Kata kunci: *Predict, Observe, Explain* (POE), *kelarutan dan hasil kali kelarutan, hasil belajar*

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▪ INTRODUCTION

Based on the 2013 revised curriculum, one of the compulsory subjects for high school students for the science group is chemistry. Chemistry is one of the most important branches of science that studies the composition, structure and nature, transformation, dynamics and energetics of matter. Chemistry learning has an abstract concept (Atagana & Engida, 2014) (Ozmen, 2004). Chemistry is considered as one of the most difficult subjects (Atagana & Engida, 2014) (Cardellini, 2012). Based on the results of a questionnaire distributed to students in 3 schools in Boyolali district, it is known that as many as 85.96% of 57 students think that chemistry is difficult to learn.

The difficulties experienced by students in studying chemistry are caused by several factors, such as: difficulty in explaining terms and difficulties in solving problems related to calculations (Yakina et al., 2017). In addition, learning difficulties in chemistry are caused by physiological, psychological, social aspects, facilities and infrastructure, learning methods, and teachers (Ristiyani & Bahriah, 2016). One of the chemical materials considered difficult by students was solubility and solubility product (Ksp). This is supported by the percentage of the National Examination score on the solubility and solubility product material which is still low. The solubility and solubility product material have a microscopic concept (Jazuli et al., 2019) and requires skills in applying the concept to more complex problems (Fitriani et al., 2019). Solubility and solubility product material contains about solubility, the influence of the namesake ion, the effect of pH on solubility, and an estimate of the occurrence of deposits.

Based on the results of questionnaires and interviews conducted with 5 teachers and 57 students at SMA N 1 Simo, SMA N 1 Teras, and SMA N 1 Banyudono, it can be seen that the chemistry books used are in accordance with the 2013 curriculum in learning activities. However, the book does not contain steps that are able to actively involve students so that learning is more meaningful. Books that are used are more dominant in developing cognitive aspects, which contain material and practice questions. Therefore, teaching materials are needed in the form of modules that are able to facilitate students to be able to study independently according to the concept discovery steps recommended in the 2013 curriculum. The module is a medium for independent learning because it is equipped with instructions for self-study (Depdiknas, 2008). The use of integrated modules in chemistry learning can increase student involvement during chemistry learning, namely in certain aspects of learning (Dumitrescu et al., 2014)

The Predict-Observe-Explain (POE) learning model is a concept discovery learning model that contains three main activities, namely: predicting, observing, and explaining. Making this prediction is important because students are required to make estimates based on the concepts they have and the functional relationships between the facts they get. After making predictions, students will see whether their predictions are correct or not through observation activities. Then students are asked to explain the suitability of predictions and observations to their friends. POE-based modules with Roundhouse can make students more active during learning because the activities contained in the module are able to facilitate students to develop mental and physical activities optimally (Nita Nuraini , Puguh Karyanto, 2014). This is in line with research (Widyaningrum et al., 2013) who concluded that the use of POE (Predict, Observe, Explain) oriented modules on Pollution material can improve student learning outcomes.

Previously, researchers had succeeded in developing a POE (Predict, Observe, Explain) based chemistry module on the solubility and solubility product material and it was found that the developed module was suitable for use in chemistry learning for high

school. However, the effectiveness of the module has not been reported. So this study aims to determine the effectiveness of using POE-based chemistry modules (Predict, Observe, Explain) on student learning outcomes.

▪ METHOD

This research is an experimental research with a pretest-posttest control group design. The sample in this study were students of class XI MIPA SMA N 1 Simo, SMA N 1 Teras, and SMA N 1 Banyudono, which was carried out using purposive sampling technique. The experimental class uses a POE-based module while the control class uses a commonly used chemistry book. The research design can be seen in Table 1.

Tabel 1. *Pretest-Posttest Control Group Design*

Class	*Pretest*	Treatment	*Posttest*
Experiment	O_1	X_1	O_2
Control	O_1	X_2	O_2

Data analysis was performed with the help of SPSS 16.0 for Windows with the paired sample t-test technique. The effectiveness test phase was carried out starting with the prerequisite analysis test in the form of a normality test and a homogeneity test then t-test.

1. Normality test is performed to determine whether data is normally distributed or not. The normality test in this study used the results of the Kolmogorov-Smirnov normality test on SPSS 16 for Windows. H_0 is accepted or the data is normally distributed if the significance value obtained is greater than $\alpha = 0.05$ (Sig> 0.05).
2. The homogeneity test is carried out to determine the variance equation. The normality test in this study used the Kolmogorov-Smirnov normality test on SPSS 16 for Windows. H_0 is accepted or the data variance is homogeneous if the significance value obtained is greater than $\alpha = 0.05$ (Sig> 0.05).
3. The statistical test in this study uses the t-test which consists of one experimental class and one control class. If the significance value> 0.05; then H_0 is accepted.

• RESULT AND DISCUSSION

Research to test the effectiveness of POE-based modules was conducted at SMA Negeri 1 Simo, SMA Negeri 1 Teras, and SMA Negeri 1 Banyudono. The effectiveness of the developed module was tested in a field test to determine the effectiveness of the module in improving student learning outcomes by measuring the difference in learning outcomes between the experimental class using modules and the control class without using modules. The module effectiveness test is calculated using the SPSS 16 program. Before testing the effectiveness of the module, a prerequisite analysis test is carried out in the form of normality and homogeneity test. The purpose of the prerequisite test is to determine the mean difference test that will be used in this study. Based on the results of the normality and homogeneity tests, all samples obtained were Sig.> α (0.05) so that it can be concluded that all samples tested were normally distributed and had homogeneous variants. Furthermore, tested with the T test (independent sample T-test) obtained Sig. < α (0.05) so that Ho is rejected and it can be concluded that there is a significant difference in the average learning outcomes between the experimental class and the control class. Based on the results of the t-test, it can be seen that the effective modules in the three schools are high, medium, and low categories. The summary of the results of the module effectiveness test is shown in Tables 2, 3, and 4.

Table 2. Normality Test Results

School	Normality test			
	Experiment		Control	
	Sig.	Result	Sig.	Result
SMA N 1 Simo	0,200	Ho accepted	0,159	Ho accepted
SMA N 1 Teras	0,066	Ho accepted	0,145	Ho accepted
SMA N 1 Banyudono	0,127	Ho accepted	0,113	Ho accepted

Table 3. Homogeneity Test Results

School	Homogeneity Test		
	Sig.	Result	Result
SMA N 1 Simo	0,399	Ho accepted	Homogeneous Variance
SMA N 1 Teras	0,085	Ho accepted	Homogeneous Variance
SMA N 1 Banyudono	0,655	Ho accepted	Homogeneous Variance

Table 4. T-test results

School	t-test		
	Sig.	Result	Result
SMA N 1 Simo	0,015	Ho rejected	Effective module
SMA N 1 Teras	0,000	Ho rejected	Effective module
SMA N 1 Banyudono	0,040	Ho rejected	Effective module

The effectiveness of the module can be seen from the differences in student learning outcomes between the experimental class and the control class. The measured learning outcomes assessment includes aspects of knowledge, attitudes, and skills.

1. Aspects of Knowledge

The knowledge aspect of the solubility equilibrium material is developed based on the syllabus. There are seven learning indicators on the solubility equilibrium material which is delivered in four meetings, namely:

a. Describes the equilibrium in a saturated solution or a salt solution that is difficult to dissolve
b. Relate the product of solubility constant to the level of solubility
c. Write down the Ksp equation for various electrolytes that are difficult to dissolve in water
d. Calculating the solubility of an electrolyte that is difficult to dissolve based on the value of Ksp or vice versa
e. Determine the pH of the solution from its Ksp value
f. Describe the effect of adding namesake ions in solution
g. Estimating the formation of deposits based on the Ksp price

Indicators a, b, c, d are implemented at the first meeting, indicator e at the second meeting, indicator f at the third meeting, and indicator g at the fourth meeting. The knowledge aspect in the module is presented in the form of material, discussion questions, and evaluation questions at the end of the chapter. The instrument used for the knowledge aspect test was a two-tier multiple choice that has been developed by other researchers. The results of the validity of the instrument were categorized as valid and the reliability

results were in the high category. Test of student knowledge as a pretest score to determine students' initial ability. Learning is continued by using modules for four meetings, then at the end of the lesson a posttest is carried out to determine any changes in student learning outcomes in understanding the learning material. The average pretest and posttest results of students can be seen in Table 5.

Table 5. Average Pretest and Posttest Results

No	School	*Pretest*	*Posttest*
1	SMA N 1 Simo		
	a. Experiment class	68,54	89,06
	b. Control class	65,83	81,88
2	SMA N 1 Teras		
	a. Experiment class	48,61	83,24
	b. Control class	56,18	73,82
3	SMA N 1 Banyudono		
	a. Experiment class	46,47	78,92
	b. Control class	55,55	74,22

Based on Table 5. above, it can be seen that the learning outcomes of the knowledge aspects of students in the experimental class using modules show better results than those without modules. This shows that the use of POE-based modules on the solubility and solubility product (Ksp) material is effective on student learning outcomes. The use of POE modules in learning can improve student learning outcomes, such as pollution material (Widyaningrum et al., 2013), and trigonometric material (Rahmawati et al., 2019).

According to (Karamustafaoğlu & Mamlok-Naaman, 2015), (Kibirige et al., 2014) and (Sreerekha et al., 2016) POE learning is very effective in improving the learning outcomes of high school students' chemistry. POE facilitates investigating scientific phenomena in small groups, then they make predictions about those phenomena. After that, observing activities are carried out to compare predictions and the results of observations that have been made. POE makes learning more interesting, can link old concepts with new discoveries so that learning received by students will be more meaningful, and can eliminate student misunderstandings and affect learning outcomes. The module that is integrated with the POE model syntax has the aim that students can learn independently and also have direct experience through predicting, observing, and explaining activities (Şeşen & Mutlu, 2016); (Fannie & Rohati, 2014).

2. Attitude aspects

Attitude aspect assessment is carried out to provide information about the value of attitudes during the learning process. The attitude aspect assessment was obtained from a questionnaire filled out by students and based on the results of observations during the learning process. Questionnaires and observations of student attitudes are used to measure spiritual attitudes and social attitudes which include cooperation, honesty, discipline, and responsibility. The results of the mean aspects of attitude can be seen in Table 6.

Table 6. Result of Average Attitude Aspect

No	School	Average Questionnaire	Observation Mean
1	SMA N 1 Simo		
	a. Experiment class	88,02	82,03
	b. Control class	84,61	78,44
2	SMA N 1 Teras		
	a. Experiment class	85,86	85,00
	b. Control class	86,99	90,15
3	SMA N 1 Banyudono		
	a. Experiment class	90,39	90,59
	b. Control class	82,97	90,00

Based on the table above, it can be seen that the mean attitude questionnaire between the experimental class and the control class does not have a significant difference. This is because the learning activities in the classroom are classified as good. Both the experimental class and the control class have a good spiritual attitude shown by praying according to their respective beliefs before and after each lesson. In addition, students' attitudes cannot only be seen from one lesson, but it is carried out over a long period of time and must be repeated. Student attitudes are not only determined by the learning media used, but there are other factors that can influence it. These factors can be in the form of internal factors that arise from within or external factors including the condition of family, friends, and the environment.

3. Aspects of Skills

In addition to the aspects of knowledge and attitudes, according to the 2013 curriculum, skills aspects are also measured as student learning outcomes. The aspect of skills in this study is the skills of students when doing practicum regarding the estimation of sediment formation based on the Ksp price. The skill aspect was assessed through observations made by 3 observers. The indicators assessed in this aspect of skills include preparing tools and materials, how to take a solution with a dropper, how to measure the solution with a measuring cup, how to maintain order and discipline, collaboration in groups, doing practice, presenting practical results, and writing reports. The results of the average skills aspect can be seen in Table 7.

Table 7. Result of Average Skills Aspect

No	School	Observation Mean Skills
1	SMA N 1 Simo	
	a. Experiment class	94,34
	b. Control class	91,67
2	SMA N 1 Teras	
	a. Experiment class	91,90
	b. Control class	91,36
3	SMA N 1 Banyudono	
	a. Experiment class	91,30
	b. Control class	89,86

Based on Table 7, it can be seen that all the average indicator achievements are very good. This shows that students are skilled in conducting experiments. Students pay attention to the teacher's explanation about how to use practicum tools and apply them properly during practicum. There is a slight difference in the average observation skills of the experimental class (using modules) which tend to be better than the control class

(without modules). This is because in the experimental class, discussion activities are listed in the module, while in the control class discussion activities are not listed even though students experience learning with the POE model. During the discussion, the experimental class was more enthusiastic in solving discussion questions than the control class.

• CONCLUSION

POE-based Chemistry Module on the solubility and solubility product material is effective for improving student learning outcomes. This is indicated by the difference in the average learning outcomes of experimental class students (using POE-based modules) which is higher than the average learning outcomes of control class students (using books) which are commonly used in three schools.

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