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DEVELOPMENT OF PREDICT-OBSERVE-EXPLAIN (POE) BASED AUTHENTIC PROBLEMS' INSTRUCTIONAL PACKAGE TO IMPROVE STUDENTS' CRITICAL THINKING SKILLS

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Abstract

Science instruction is required to be able to develop critical thinking skills and solve various authentic problems. However, based on the preliminary study results, the science learning process does not emphasize the development of critical thinking skills. Therefore, this study aims to produce appropriate POE (Predict-Observe-Explain) based authentic instructional package that are valid, practical, and effective to improve students' critical thinking skills. This research is educational development research using Tessmers' development model, which includes self-evaluation, expert test, individual test, small group test, and field test. The subjects of the research trial were eight students of class VIIIE and 29 students of class VIIIF of SMPN 33 Banjarmasin. The research data were obtained by expert testing on assessment using validation instruments, observations on practicality assessment using RPP implementation instruments, and tests on effectiveness assessment using critical LP instruments. The results of the data were analyzed quantitatively and qualitatively and the results obtained that the learning tools were categorized as very valid, practical, and effective. Therefore, a POE (Predict-Observe-Explain) based authentic problem instructional package is feasible to improve students' critical thinking skills.

Keywords: *Predict-Observe-Explain, Authentic Problem, Critical Thinking Skills*

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INTRODUCTION

Students as future assets must be equipped with high-level thinking skills that are following the demands of the current era. According to the Ministry of Education and Culture (2013), higher-order thinking skills are closely related to intellectual and communication skills. Higher-order thinking skills can be trained by solving various kinds of authentic problems. Authentic problems are problems related to everyday events that depart from various problems that are actually found or may be found, or found solutions in everyday life (Setya et al., 2016).

Science learning as a part of education is required to produce students who have the competence to carry out scientific methods to solve authentic problems and develop higher-order thinking skills including critical thinking skills. Critical thinking skills in science are related to how to find out and understand concepts, theories or formulas in-depth so that students are required to be able to actively build knowledge in the learning process (Putri et al., 2021).

Many students' critical thinking skills in Indonesia are still relatively low. Some of the findings that underlie these facts include Wijayanti (2015) who in his analysis in one of the districts in the province of Bali obtained information that the critical thinking skills of students were mostly still in the low category. This is supported by Pradana (2017) in his research in one of the districts in East Java finding the fact that most of the student's critical thinking skills are also still relatively weak. Consistent with the findings of Kassiavera (2019) in his research in one city in Central Java province, students' critical thinking skills are still low. Ulfah's analysis (2020) also strengthens the findings that have been described, his analysis in one district in South Kalimantan obtained information that the level of mastery of critical thinking skills was only around 38%.

Learning to practice critical thinking skills cannot be done if the teacher teaches more using the lecture method and is not accustomed to designing a instructional package and implementing critical thinking skills-based learning. Learning at every level of education should be focused on developing critical thinking skills. Critical thinking skills can be achieved if students can identify problems, analyze, inference, and evaluate (Subiantoro & Fatkurrohman, 2009). Most teachers are still not aware of this, so the learning process has not been able to develop critical thinking skills to the fullest. Therefore, there is a need for improvements in learning, especially learning innovation can be done by trying learning with learning stages that can help train students' critical thinking skills. The application of learning that can train critical thinking skills must of course be accompanied by the development of the design of the instructional package.

The learning process to train critical thinking skills can be done by applying the Predict-Observe-Explain (POE) learning model. White & Gunstone (1992) in Kearney (2004) revealed that POE contains three stages which include prediction, observation and explanation. At the prediction stage, students make predictions and

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predict the results of experiments that will be carried out at the next stage. Students then observe the phenomena that occur or see experiments in the observation phase. In the last stage, students compare their observations with predictions and then explain the observations with their knowledge. POE begins with a prediction that is closely related to the hypothesis. Furthermore, this hypothesis was tested by investigating observation activities to find the data findings. Then students analyze the data findings and associate them with reason, theory, and facts and evaluate hypotheses based on the data findings so that they require them to think critically (Annur et al., 2015; Yulianto et al., 2014).

The problems presented can be in the form of authentic problems, namely problems related to daily events that depart from various problems that are actually found or may be found, or found solutions in everyday life (Setya et al., 2016). Thus, the authentic problem-based POE model is a learning model that emphasizes prediction, observation, and explanation activities for problems that actually occur or may occur in everyday life. The steps of authentic problem-based POE learning are presented as follows in Table 1.

Table 1. Learning steps *POE* -based authentic problem

Phase	Learning Activity
Predicting an authentic problem (Predict)	Providing apperception in the form of a description of a problem that occurs or may occur in everyday life related to the material to be discussed.
Make observations on problems that have been predicted (Observe)	As a facilitator and mediator if students have difficulty making observations.
Hold a presentation to explain the suitability between predictions and observations (Explain)	Facilitate the discussion if students experience difficulties.

(adaptation Suparno, 2006; Setya et al., 2016)

The main stages of learning described above are stages of learning that are suitable for spurring students to develop their potential to improve their critical thinking skills. Students are invited to critically find their solutions to the authentic problems given.

POE learning has previously been applied in Annur's research (2015) with the result that the POE model can improve student learning outcomes. In addition, research using POE learning has also been applied by Yulianto (2014), Amirullah (2019), Setiawan (2017), and Fahrinnisak (2018) and the results show that the application of the POE learning model can improve students' critical thinking skills. All the studies that have been mentioned, if considered, have something in common, namely that the research is only the application of POE learning without the development of POE instructional package combined with aspects of authentic problems.

METHODS

This research is part of educational research with the Tessmer

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model which consists of stage self-evaluation, expert review, one-to-one, small group, and field test. The instructional package developed with the model POE -based authentic problem consists of a Lesson Plan (RPP), Teaching Materials, Student Activity Sheets (LKPD), and Assessment Sheets. The research subjects at the expert review stage were 3 science education experts from master science teacher lecturers and 2 senior science education practitioners. One to one test subjects were 3 representatives of class VIII students at SMP Negeri 33 Banjarmasin. The small group test subjects were 8 students of class VIII SMP Negeri 33 Banjarmasin. The field test subjects were 29 students of class VIII SMP Negeri 33 Banjarmasin.

The feasibility of the developed device is determined from the results of the validation, practicality, and effectiveness tests based on the development stages of the Tessmer model. Techniques for collecting device validation data using expert test techniques or expert reviews that are assessed based on the developed device validation instrument. The average score of the assessment results from the three expert validations and the two practice validations was adjusted according to the criteria in Table 2.

Table 2. Instructional package validation assessment criteria

Interval Score	Assessment Category
Predicting an authentic problem (Predict)	Providing apperception in the form of a description of a problem that occurs or may occur in everyday life related to the material to be discussed.
Make observations on problems that have been predicted (Observe)	As a facilitator and mediator if students have difficulty making observations.
Hold a presentation to explain the suitability between predictions and observations (Explain)	Facilitate the discussion if students experience difficulties.

(adaptation Suparno, 2006; Setya *et al*., 2016)

Practicality is determined at the small group stage and field testing. The practicality data was obtained by observing the implementation of the RPP carried out by 2 observers that using observation instrument. The observation data was analyzed quantitatively descriptively with the following equation.

$$P = \frac{\sum \mathrm{K}}{\sum \mathrm{N}} x\ 100$$

Description:
P : Score of RPP implementation
$\sum$K : Total score of aspects that are implemented
$\sum$N : Total maximum score of all aspects
The score of RPP implementation is then adjusted to the assessment criteria in Table 3.

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Table 3. Criteria for assessing the implementation of RPP

Interval Score	Assessment Category
80 < X	Very high
60 < X ≤ 80	High
40 < X ≤ 60	Average
20 < X ≤ 40	Low
X ≤ 20	Very low

(Widoyoko, 2016)

Effectiveness is determined by increasing critical thinking skills analyzed from the acquisition scores pre-test and post-test of students with the following equations and criteria.

$$\text{KBK value} = \frac{\sum K}{\sum N} x\ 100$$

Description:

KBK Value : Score critical thinking skills
∑K : Total score obtained
∑N : Total maximum score

The score of critical thinking is then adjusted to the assessment criteria in Table 4.

Table 4. Criteria for critical thinking skills assessment

Interval Score	Assessment Category
80 < X	Very high
60 < X ≤ 80	High
40 < X ≤ 60	Average
20 < X ≤ 40	Low
X ≤ 20	Very low

(Agnafia, 2019)

Then N-gain analysis with the following equations and criteria

$$N - gain = \frac{S_{post} - S_{pre}}{S_{maks} - S_{pre}}$$

Description:

N-gain : Normalized index value gain
Spost : Scores *Post-test*
Spre : *Pre-test score*
Smaks : The maximum value

The N-Gain is then adjusted to the assessment criteria in Table 5.

Table 5. Criteria gain normalized index values

Normalized Index Value Gain (N-gain)	Criteria
(N-gain) > 0.70	High
0.30 ≤ (N-gain) ≤ 0.70	Average
(N-gain) < 0.30	Low

(Archambault , 2008)

RESULTS AND DISCUSSION

The development is carried out by considering curriculum needs and student characteristics based on initial studies. The learning package is designed by integrating the stages of the model *POE* with indicators of critical thinking skills which include

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making assumptions, recognizing problems, analyzing, making conclusions, and evaluating with presenting problems in the form of authentic problems. The feasibility of the developed device is assessed from three indicators, namely valid, practical, and effective.

1. Validity

Validity of the learning package was obtained from the validation results in the test expert review by five experts on lesson plans, teaching materials, LKPD, and assessment sheets. The assessment technique used is to take the average score given by the validator to be categorized based on Table 2. The recapitulation of the results of the validation of The learning Package can be seen in Table 6.

Table 6. Recapitulation of the validation of learning package

Part of Package	Average Score	Validity Category
RPP	3.65	Very Valid
Teaching materials	3.69	Very Valid
LKPD	3.80	Very Valid
Assessment sheet	3.51	Very Valid

The learning package *POE* - based *authentic problem* belongs to the very valid category with few revisions. These results mean that there is consistency and relevance of each component of The learning package. Each component of The learning package is composed of content that can stimulate and train students' critical thinking skills. A device is said to be valid if it is relevant to the goal and each of its components is compatible with each other and can measure what it wants to measure (Taherdoost, 2016).

Learning steps *POE*, include clear reference sources and learning media and include critical thinking skills instruments. In line with Miyati's findings (2019) that a valid lesson plan is a lesson plan that has an organized concept by containing clear and relevant learning steps to the competencies that must be mastered by students. Teaching materials are classified as valid, designed by taking into account the orientation of students' activities so that they can construct their knowledge so that they are relevant to the competencies that must be mastered. This result is consistent with Suniasih (2019) that valid teaching materials are teaching materials that are arranged systematically and allow students to construct their knowledge.

LKPD is valid because it has a systematic structure with complete components and emphasizes the process aspect of finding concepts. Accurate presentation of cases supported by the use of attractive images is strength in LKPD. Banjarani (2020) revealed that a valid LKPD is an LKPD that is presented systematically, can support the smooth learning process and is relevant to learning objectives.

The assessment sheet is classified as valid because it has a very good display quality with the selection of the appropriate type and font size.

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Assessment sheets are typically designed systematically and contain test instruments that are formulated according to critical thinking skills indicators so that they can accurately measure students' critical thinking skills. Hidayat's research results (2015) and Nurjananto (2015) stated that a valid assessment sheet is an appropriate assessment sheet in measuring what you want to measure.

This authentic problem-based POE Learning Package belongs to the very valid category. Learning Package is considered capable of being a facility to train students' critical thinking skills and can make students more active in the learning process. The contents of the lesson plans are composed of objectives and activities that can train students' critical thinking skills and are supported by teaching materials and worksheets that present authentic problems to be able to train students' critical thinking skills. The assessment sheet also consists of questions that present authentic problems that can measure students' critical thinking skills.

2. Practicality

The practicality of learning package is determined from the implementation of the lesson plans and the responses of students in the small group and field test stages. The implementation of the lesson plans is viewed from two aspects, namely the assessment of teacher activities and student activities.

The results of observations of teacher activities in the small group test (Small Group) and (Field Test) can be seen in Table 7 and the results of observations of student activities can be seen in Table 8.

Table 7. Recapitulation of the average teacher activity

Test	Activity	Score for Each Meeting				Average Score	Category
		1	2	3	4		
Small group	teacher asks students to make predictions about authentic problems	100.0	100.0	100.0	100.0	100.0	SB
	teacher guides students to conduct experiments related to authentic problems presented	90.3	86.1	93.1	91.7	90.3	SB
	teacher guides the students to conclude and explain the experimental results and their predictions	93.8	87.5	90.6	91.7	90.9	SB
Field test	teacher asks students to make predictions about authentic problems	90.6	90.6	93.8	93.8	92.2	SB
	Teachers guide students to conduct experiments related to authentic problems presented	94.4	93.1	88.9	91.7	92.0	SB

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	Teachers guide students to conclude and explain experimental results and predictions	93.8	96.9	96.9	87.5	93.8	SB

Keterangan: SB = Very good

Table 8. Recapitulation of the average activity of students

Test	**Activity**	**Score for Each Meeting**				**Average Score**	**Category**
		1	**2**	**3**	**4**		
Small group	Students make predictions about authentic problems	100.0	100.0	100.0	100.0	100.0	SB
	Students conduct experiments related to authentic problems presented	90.3	86.1	93.1	91.7	90.3	SB
	Students conclude and explain the relationship between the experimental results and their predictions	93.8	87.5	90.6	91.7	90.9	SB
Field test	Students conduct experiments related to authentic problems presented	94.4	93.1	88.9	91.7	92.0	SB
	Students conclude and explain the relationship between the experimental results and their predictions	93.8	96.9	96.9	87.5	93.8	SB

Keterangan: SB = Very good

Practicality is the level of convenience that exists in evaluation instruments or devices both in preparing, using, obtaining results, as well as convenience in storing them The ease with which teachers apply Learning Package is shown based on teacher activities and student activities.

Teacher activities in both limited and wide trials can be carried out well. It means that teachers can carry out *POE* -based *authentic problem* well, Coherent with Fahrinnisak (2018) which reveals that the *POE* can be applied by teachers very well. The practicality of learning can be seen from the teacher's ability to carry out learning (Singh, 2016).

Learning in *POE* -based *authentic problem* limited trials and broad trials can be carried out well. Students can respond to activities facilitated by the teacher by carrying out learning activities contained in the lesson plans. In Fahrinnisak (2018) it is stated that the *POE* can also be applied by students very well because the *POE* in the learning process involves students directly and participates in thinking in problem-solving.

3. Effectiveness

The effectiveness of learning package in terms of increasing the value of students' critical thinking skills. The students' critical thinking skills are known from the results of the *pre-test*, namely the tests conducted before the start of learning and the results *post-test*, namely the tests

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carried out after learning using learning package *POE* -based *authentic problem*.

a. Small Group

The small group test was conducted on a limited basis, involving only 8 students to find out whether The learning Package was suitable for field testing. The results of the *pre-test* and *post-test* of students in the small group test are presented in Table 9.

Table 9. Data pre-test and post-test on critical thinking skills in the small group test

Name	*Pre-test*			*Post-test*			*N- Gain*	
	Total	Value	Category	score	Value	Category	*g*	Category
SK 1	8	33.33	Low	20	83.33	Very high	0.75	High
SK 2	7	29.17	Low	20	83.33	Very high	0.76	High
SK 3	7	29.17	Low	19	79.17	High	0.71	High
SK 4	7	29.17	Low	19	79.17	High	0.71	High
SK 5	6	25.00	Low	18	75.00	High	0.67	Average
SK 6	9	37.50	Low	19	79.17	High	0.67	Average
SK 7	8	33.33	Low	20	83.33	Very high	0.75	High
SK 8	6	25.00	Low	18	75.00	High	0.67	Average

Keterangan: SK= Student in small group

The increasing score on the small group test in detail can be seen in the average recapitulation of *N-gain* the whole presented in Table 10.

Table 10. N-gain small group

Average Group' Score		**N-Gain**	
Pre-test	**Post-test**	**g**	**Category**
30.21	79.69	0.71	High

Based on Table 10. available that in general there is an increase in critical thinking skills in small groups, namely with an *N-Gain* of 0.71 in the high category.

b. Field Test

The field test is carried out after the small group test. The pre-test and post-test students on field tests can be seen at the recapitulation of the pre-test and post-test are presented in Table 11.

Table 11. Data pre-test and post-test critical thinking skills in the field test

Name	**Pre-test**				**Post-test**		**N- Gain**	
	Total	**Value**	**Category**	**score**	**Total**	**Value**	**Score**	**Category**
SF 1	8	33.33	Low	20	83.33	Very high	0.75	High
SF 2	7	29.17	Low	17	70.83	High	0.59	Average
SF 3	8	33.33	Low	20	83.33	Very high	0.75	High
SF 4	8	33.33	Low	20	83.33	Very high	0.75	High
SF 5	6	25.00	Low	18	75.00	High	0.67	Average
SF 6	6	25.00	Low	18	75.00	High	0.67	Average
SF 7	8	33.33	Low	21	87.50	Very high	0.81	High
SF 8	6	25.00	Low	20	83.33	Very high	0.78	High

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Name	Pre-test				Post-test		N- Gain	
	Total	Value	Category	score	Total	Value	Score	Category
SF 9	7	29.17	Low	19	79.17	High	0.71	High
SF 10	7	29.17	Low	18	75.00	High	0.65	Average
SF 11	8	33.33	Low	18	75.00	High	0.63	Average
SF 12	6	25.00	Low	18	75.00	High	0.67	Average
SF 13	6	25.00	Low	18	75.00	High	0.67	Average
SF 14	6	25.00	Low	21	87.50	Very high	0.83	High
SF 15	6	25.00	Low	18	75.00	High	0.67	Average
SF 16	6	25.00	Low	17	70.83	High	0.61	Average
SF 17	8	33.33	Low	20	83.33	Very high	0.75	High
SF 18	7	29.17	Low	21	87.50	Very high	0.82	High
SF 19	9	37.50	Low	21	87.50	Very high	0.80	High
SF 20	7	29.17	Low	19	79.17	High	0.71	High
SF 21	6	25.00	Low	19	79.17	High	0.72	High
SF 22	6	25.00	Low	17	70.83	High	0.61	Average
SF 23	7	29.17	Low	21	87.50	Very high	0.82	High
SF 24	7	29.17	Low	21	87.50	Very high	0.82	High
SF 25	6	25.00	Low	21	87.50	Very high	0.83	High
SF 26	9	37.50	Low	19	79.17	High	0.67	Average
SF 27	8	33.33	Low	18	75.00	High	0.63	Average
SF 28	8	33.33	Low	19	79.17	High	0.69	Average
SF 29	6	25.00	Low	18	75.00	High	0.67	Average

Keterangan: SF= Student in field test

The increase in the value in the field test can be seen in the recapitulation average *of the the N-Gain* overall presented in Table 12

Table 12. N-gain field test

Average Group' Score		*N-Gain*	
Pre-test	***Post-test***	***g***	**Category**
29.17	79.74	0.71	High

The developed device is categorized as effective if the learning package can achieve the research objectives. Effectiveness is obtained if there is a relationship between the objectives and the results of learning or in other words effectiveness is the level of achievement of learning objectives, namely increasing critical thinking skills. The effectiveness measured includes only five indicators of critical thinking skills, namely making assumptions, recognizing problems, analyzing, drawing conclusions, and evaluating.

The results obtained in this study were considered effective as seen from the analysis of N-gain which was in the high category based on the results of the pre-test and post-test in the small group and field test. Based on these results, it means that the students' critical thinking skills as a whole experienced a significant increase. The learning Package is said to be effective if it can improve students' critical thinking skills with *N-Gain* (Yuliato,

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2014). Coherent with Annur's findings (2015) that the use of *POE* is seen as able to make students explore their knowledge so that they can develop the reasoning power of students

Model POE is effective in improving students' critical thinking skills because student activities at each stage of POE are maximal so that students can practice critical activities so that students are accustomed to solving problems related to critical thinking indicators (Setiawan, 2017). There are five indicators of critical thinking that must be achieved by students, namely making assumptions, recognizing problems, analyzing, making conclusions, and evaluating. POE consists of three main phases, namely prediction, which can train the ability to make assumptions because students are allowed to make a prediction or conjecture on a phenomenon along with the reasons. Furthermore, in the observation phase, students are allowed to practice the ability to recognize problems, analyze, and make conclusions as a series of experiments to test the truth of the predictions they convey. Then in the explanation phase, students can practice evaluating skills because students must explain the suitability of the findings with the predictions that have been made. The use of authentic problems in the components of the learning package can train the power of analysis and association between reason and everyday facts so that it plays an important role in improving students' critical thinking skills.

The limitation of this study is that this study still measures skills only in the cognitive domain, not including measurements in the affective and psychomotor domains. Therefore, in the future, research that covers the affective and psychomotor domains is needed with an authentic problem-based POE model.

CONCLUSION AND RECOMMENDATION

The conclusion that can be drawn from the results of this research is the production of model devices *POE* authentic problem-based which are categorized as valid, practical, and effective. The learning package developed by the researcher aims to train critical thinking skills which are higher-order thinking skills. So that the authentic problem-based POE model device can be an alternative to prepare students who are highly competent and can compete in the millennial era or the 21st century.

This research is still limited to cognitive skills, not including skills in affective and psychomotor. Therefore, it is recommended in the future, research that covers the affective and psychomotor domains can be presented with an authentic problem-based POE model.

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