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Modified POE Learning Model: Its Effect on Students' Science Learning Motivation and Critical Thinking Skills

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Abstract: This research aims to describe and explain simultaneously whether there are differences in science learning motivation and critical thinking skills of students who learn using different learning models. The experimental class is with modified POE, while the control class is with a conventional learning model. This type of research is a quasi-experimental research design with a nonequivalent pretest-posttest control group design. The data obtained were analyzed descriptively and the hypothesis was tested using MANCOVA. The research results showed that simultaneously there were significant differences in science learning motivation and students' critical thinking skills between the experimental and control classes in terms of the results of the analysis of the students' achievements. The modified POE learning model is better at increasing students' science learning motivation and thinking skills compared to 5M learning.

Keywords: 5M; Study science; Critical Thinking Skills; Motivation; POE.

Introduction

The 2013 curriculum is the government's effort to achieve the demands of the 21st century, namely the quality of human resources becoming increasingly competent (Asy'ari & Hamami, 2020). Learning that adheres to the 2013 Curriculum, one of which emphasizes the development of the 4C aspects: creative, critical thinking, communicative, and collaborative (Sulaksana, 2020). This aims to produce a generation equipped with good knowledge, skills, and attitudes so that they can survive all challenges in the present and in the future (Mardhiyah et al., 2021; Rawung et al., 2021). Learning carried out according to the 2013 Curriculum must meet the characteristics of 21st-century learning. First, motivate students to seek knowledge. Second, it leads to problem formulation activities. Third, train students to make decisions. Fourth, there are collaborative activities in solving problems (Febri et al., 2019).

The POE (Predict, Observe, Explain) learning model is a model that meets the characteristics of 21st-century learning because it invites students to build knowledge through the experiences and challenges provided so that they can learn independently (Parwati et al., 2020). Logical, systematic learning activities and carrying out scientific work in POE learning can develop students' thinking skills. Such activities provide learning experiences that involve all students' attitudes and abilities (Khoiri, 2021). Judging from the characteristics and findings of previous research, the POE learning model can increase students' learning motivation and critical thinking skills (Hermita et al., 2019; Setiyani et al., 2019; Simarmata & Djulia, 2019).

However, on the other hand, there are inconsistencies in the implementation of the POE learning model steps, especially in the second syntax, that is observed. Nawawi, et al. (2013) implemented the POE model using media at the observe stage. Apart from that, research conducted by Ma'rifatun, *et al*. (2014) tried to compare experimental activities with observing

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demonstrations by teachers, the results were that demonstrations gave less effective results. In fact, the observed step in the POE learning model experienced a development as stated by Liew (2004) into students carrying out experimental activities. Experimental learning activities must be filled with conducting experiments, analyzing, interpreting, and drawing conclusions (Memes, 2000).

This inconsistency attracted the attention of researchers to make modifications by inserting aspects of basic and integrated science process skills to complement and reinforce the learning experience in each syntax of the POE learning model. Learning experiences can increase learning motivation, considering that learning motivation plays an important role in building conceptions (Tuan et al., 2005), and achieving student learning outcomes (Azhari et al., 2020; Sudiatmika et al., 2019). This is related to previous research which shows that learning motivation is still low due to conventional learning which is less attractively implemented in the classroom (Hadisaputra et al., 2020; Ilyas & Liu, 2020; Ramdani et al., 2020), so learning is needed that provides learning experiences meaningful to students.

Activities in the observation step in the modified POE model are filled with experiment planning activities which include formulating hypotheses, determining variables, determining tools and materials, preparing work steps, and observing. This activity can increase student independence in solving a problem. Apart from that, it can develop students' critical thinking skills (Mubarokah et al., 2017). Science process skills applied in learning have also been proven to improve critical thinking skills (Perdana et al., 2017; Pradana et al., 2020).

Critical thinking skills are one of the skills that need to be mastered nowadays, but in fact, the level of students' critical thinking skills is still relatively low (Aini et al., 2020; Febri et al., 2019; Purwanto et al., 2019; Rahayu et al., 2019; Saputri et al., 2018; Zubaidah et al., 2018). Mastery of critical thinking skills needs to be mastered optimally by using effective learning models and supporting the development of student's skills.

The considering the need to foster learning motivation and develop students' critical thinking skills, the combination of the POE learning model with aspects of basic and integrated science process skills (modified POE) is theoretically thought to be able to increase learning motivation and critical thinking skills simultaneously. However, limited studies on the modified POE learning model and the success of this learning depend on the level of readiness of students, causing doubts regarding its effect on science learning motivation and critical thinking skills simultaneously. The aim of this research is to describe and explain differences in critical thinking skills.

Method

The type of research carried out is quantitative research. The first step taken in this research is preparing the RPP and LKPD that will be used in carrying out the treatment. Apart from that, a research instrument was also prepared. The instruments used were questionnaires and tests. Questionnaires were used to collect science learning motivation data, while critical thinking skills data was obtained through tests. The science learning motivation questionnaire instrument used in this research refers to the indicators proposed by Uno (2013), while the critical thinking skills indicators which are used as a reference in compiling critical thinking skills test instruments use the indicators stated by Facione (1990). The research instrument is then tested for validity and reliability to find out whether it is suitable for use in research. If the instrument does not meet the requirements, it will be revised and discussed with experts.

The next step is to determine the research sample. The sample for this research was two study group classes (rombel) which were chosen randomly using the cluster random sampling technique. The sample came from the entire population of class VIII students in semester 2 of the 2022/2023 academic year at SMP Negeri 5 Mengwi, Badung Regency, Bali. The two classes of groups used as samples were divided into experimental and control classes. The experimental class was given treatment with a modified POE learning model, while the control class received 5M learning. The variables of this research consist of independent variables (modified POE learning model and conventional learning), dependent variables (science learning motivation and critical thinking skills), and covariate variables (pretest scores for science learning motivation and critical thinking skills).

The research design uses a nonequivalent pretest posttest control group design which is presented in Table 1 (Sugiyono, 2017). The research data acquisition stage followed the design above, namely carrying out a pretest before the treatment, followed by a posttest after the treatment was carried out three times. The data obtained was then analyzed descriptively and the hypothesis tested using MANCOVA (Multivariate Analysis of Variance) analysis. MANCOVA analysis was carried out after the data had gone through prerequisite analysis tests consisting of multivariate normality tests, homogeneity of variance, homogeneity of variance-covariance, linearity, the slope of the

regression line, and collinearity (Facione, 1990; Uno, 2013).

Table 1. Nonequivalent pretest posttest control group design

Class	Pretest	Treatment	Posttest
Experiment	O_1	X	O_2
Control	O_3	Y	O_4

Description
O_1 : Experimental class Pretest
O_2 : Experimental class Posttest
O_3 : Control class Pretest
O_4 : Control class Posttest
X : Experimental class treatment
Y : Control class treatment

Result and Discussion

The results of descriptive data analysis show that there are differences in the average scores of students' science learning motivation and critical thinking skills between the experimental class and the control class. Students who studied with the modified POE learning model had higher average posttest scores for science learning motivation and critical thinking skills than students who studied with conventional learning in the control class. Initial and final data on students' science learning motivation and critical thinking abilities are presented in Tables 2 and 3.

Table 2. Initial and final data on motivation to learn science

Descriptive Analysis	Control Class		Experimental Class	
	Pretest	Posttest	Pretest	Posttest
Average	52.69	72.42	52.63	77.45
Standard Deviation	4.81	7.69	4.56	5.71

Table 3. Initial and final data on critical thinking skills

Descriptive Analysis	Control Class		Experimental Class	
	Pretest	Posttest	Pretest	Posttest
Average	27.03	46.78	29.21	60.96
Standard Deviation	6.55	9.51	8.27	9.74

Tabel 4. Initial and final data on motivation to learn science

Effect		F	Sig.
Class	Pillai's Trace	20.68[a]	0.00
	Wilks' Lambda	20.68[a]	0.00
	Hotelling's Trace	20.68[a]	0.00
	Roy's Largest Root	20.68[a]	0.00

Data on science learning motivation and critical thinking skills were also analyzed using the MANCOVA hypothesis test, the results of the analysis are presented in Table 4. Based on Table 4, the values of Pillai's Trace, Wilks' Lambda, Hotelling's Trace, and Roy's Largest Root each have a value of F = 20.684 with a sig value of 0.000. The significance value obtained is less than 0.05 so the alternative hypothesis is accepted. This means that there is a significant difference between science learning motivation and students' critical thinking skills in the experimental class and the control class. The average science learning motivation of students who study with the modified POE learning model is higher than students who study with conventional learning. This is caused by the learning activities carried out. The modified POE model makes students interested in learning, so that motivation is high to understand the topic being studied (Simarmata & Djulia, 2019).

The modified POE model involves students actively and gives students the freedom to explore in search of their own knowledge. This conditioning has a positive impact in the form of encouraging the desire to try to be more active in learning activities (Nur'Azizah et al., 2021; Sari et al., 2021; Yanti et al., 2023). The more students involve themselves in learning activities, the more their thinking abilities in solving problems will develop. Learning activities that empower science process skills, students tend to have high learning motivation and influence students' critical thinking skills (Fajari et al., 2020; Hermita et al., 2019; Nugraha et al., 2017). Activities with science process skills train students' abilities such as identifying cause and effect or relationships, identifying or creating questions, formulating hypotheses, and designing experimental activities so as to help students independently build knowledge and train their thinking abilities (Rizki et al., 2021). Learning activities in the experimental class are presented in Figure 1.

(a) (b)

Figure 1. (a) Students design experiments, (b) Students carry out experiments according to the design they have made

Motivation to learn and critical thinking skills are related. Students with high learning motivation will have better critical thinking skills than students with low learning motivation (Dewanthikumala et al., 2021; Miharja et al., 2021; Rini et al., 2020). However, this is not in line with the findings of this research, namely the results of the collinearity test between learning

motivation and critical thinking skills of 0.230 ($r < 0.8$). This means that the dependent variable does not have a significant relationship. It means, in terms of average achievement scores, science learning motivation is in the high category, while the average critical thinking ability is in the sufficient (experimental class) and low (control class) categories.

This may occur due to factors other than learning motivation, as learning motivation itself is affected by both intrinsic and extrinsic factors. Factors that can influence the achievement of critical thinking skills are physical condition, anxiety, different intellectual development between students, study habits, understanding of concepts, place of study, friends, and intensity of training (Dini et al., 2023; Marina et al., 2020; Muwaffiq et al., 2022; Liyanto et al., 2020). Students' inability to think critically can also be caused by not being familiar with carrying out activities that involve critical thinking skills, apart from that it is also influenced by students' low understanding and mastery of concepts when solving problems so that students' achievement of critical thinking skills is not optimal (Kurniahtunnisa et al., 2023; Yanti et al., 2023). However, on the other hand, the modified POE model has advantages in the predict and observe stages which respectively provide students with challenges, responsibilities and various activities that foster learning motivation and train students' critical thinking skills (Herzberg, 1966; Yuenyong & Yuenyong, 2021).

Conclusion

Based on the results and analysis, it can be concluded that simultaneously there is a significant difference in the science learning motivation and critical thinking skills of experimental class students and control class students. The modified POE learning model is better at increasing science learning motivation and critical thinking skills than conventional learning models.

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Author Contributions
Authors have their own contributions. Fatimah Millenia Fauziah conducted the investigation, analyzed the data, and wrote the draft; A. A. Istri Agung Rai Sudiatmika, M.Pd carries out supervision and reflection; and Dr. I Wayan Suja, M.Si who worked on the review writing draft.

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The authors declare no conflicts of interest.

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