



Learning Methods and Critical Thinking Ability on Science Learning Outcomes

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ABSTRAK

Banyak cara yang bisa dilakukan dalam upaya meningkatkan hasil belajar IPA di sekolah. Salah satu caranya adalah dengan memilih metode pembelajaran yang tepat. Penelitian ini bertujuan untuk melihat pengaruh metode pembelajaran eksperimen, metode pembelajaran ekspositori dan kemampuan berpikir kritis terhadap hasil belajar sains. Penelitian ini dilaksanakan dengan sampel 74 mahasiswa. Desain penelitian menggunakan metode eksperimen dengan treatment by level 2 x 2. Analisis data menggunakan analisis varian 2 jalur (ANOVA). Hasil penelitian ini adalah adanya perbedaan hasil belajar sains mahasiswa yang belajar dengan metode pembelajaran eksperimen antara mahasiswa yang belajar dengan metode pembelajaran ekspositori; adanya interaksi antara metode pembelajaran dan kemampuan berpikir kritis mahasiswa terhadap hasil belajar sains; hasil belajar sains antara mahasiswa yang belajar dengan metode pembelajaran eksperimen yang memiliki kemampuan berpikir kritis tinggi lebih tinggi dari pada

mahasiswa yang belajar dengan metode pembelajaran ekspositori yang memiliki kemampuan berpikir kritis tinggi; hasil belajar sains antara mahasiswa yang belajar dengan metode pembelajaran eksperimen yang memiliki kemampuan berpikir kritis rendah lebih rendah dari pada mahasiswa yang belajar dengan metode pembelajaran ekspositori yang memiliki kemampuan berpikir kritis rendah. Penelitian ini mengimplikasikan bahwa penerapan metode pembelajaran eksperimen dapat meningkatkan keterampilan berpikir kritis siswa sehingga dapat meningkatkan hasil belajar siswa.

ABSTRACT

There are many ways that can be done in an effort to improve science learning outcomes in schools. One way is to choose the right learning method. This study aims to see the effect of experimental learning methods, expository learning methods and critical thinking skills on science learning outcomes. This research was conducted with a sample of 74 students. The research design used an experimental method with treatment by level 2 x 2. Data analysis used 2-way analysis of variance (ANOVA). The results of this study are that there are differences in the results of students learning science with experimental learning methods between students who learn using expository learning methods; there is an interaction between the learning method and students' critical thinking skills on science learning outcomes; The results of learning science between students who learn with experimental learning methods who have higher critical thinking skills are higher than students who learn using expository learning methods who have high critical thinking skills; The results of learning science between students who learn with experimental learning methods who have low critical thinking skills are lower than students who learn using expository learning methods who have low critical thinking skills. This study implies that the application of experimental learning methods can improve students' critical thinking skills so that it can improve student learning outcomes.

1. Introduction

Natural science is a branch of science that studies everything in nature and its symptoms (Kelana & Pratama, 2019; Samsudin et al., 2019). The position of science in Indonesia's curriculum is one of the integrated subjects that is important for teaching (Kompetensi Dasar Kurikulum, 2013). Collete &

Chiappetta (1994) state that science is a body of knowledge, thinking, and a way of investigating. The PISA study in science in 2018 shows that Indonesia is ranked 72 out of 78 countries with a score of 396 (Kelana & Pratama, 2019). These data indicate that the quality of science learning in Indonesia is still shallow. Therefore, it is necessary to make efforts to improve science learning outcomes, especially in schools.

Many ways can be done in seeking to improve science learning outcomes in schools. One way is to choose the right learning method. Following the nature of science itself, as a way of investigation, experimental and expository methods are seen as one of the appropriate methods used to improve student science learning outcomes. The method involves teachers and students to provide experience for the fact-finding process of a theory or concept (Liberna, 2012). Wijaya (2017) showed that experimental methods could make students confident, develop their attitudes, develop exploratory attitudes, enrich experiences objectively and realistically, develop scientific attitudes and learning outcomes.

Meanwhile, the expository method combines lecture, question and answer, and development methods (Ma'ruf, 2018). Many think that the expository method only focuses on the teacher as the primary source and information provider. However, if optimized, this method makes the teacher learning centered and makes the teacher a facilitator in learning. Vivitri & Sunardi (2018) did this by optimizing the expository method to improve student learning outcomes.

Science learning is also seen as a way of thinking, and this shows that science learning can be used as a means of increasing students' critical thinking skills (Wicaksono, 2014; Wardani, 2020) or vice versa, the level of students' critical thinking skills can support students' understanding of science learning (Husnah, 2017). The ability to think critically is one of the abilities that need to be mastered in life (Wulandari et al., 2015). Critical thinking is a process of analyzing in-depth things, asking questions, finding information, introspective and productive thinking and events (Fisher, 2011; Santrock, 2007). Studies show that elementary students' critical thinking affects their learning outcomes and motivation (Sanderayanti, 2015).

Previous research has shown several methods and higher-order thinking skills that have been proven to be appropriate in improving student science learning outcomes. In this study, the researcher will focus on investigating the experimental group driving the experiment and the expository and seeing the effect of students' low and critical thinking skills on their science learning outcomes.

2. Method

This research is quantitative research. The method used is an experimental method with a treatment design by level 2 x 2. It consists of three research variables: the independent variable, namely the learning method consisting of experimental (A₁) and expository (A₂) methods. The moderate variable is critical thinking ability which consists of high critical thinking ability (B₁) and low critical thinking ability (B₂). The dependent variable is the learning outcome. The correlation of research variables can be seen in the following table.

Table 1. Design of Treatment by level 2 X 2

Lear Method Ability Critical thinking	Experiment Method A ₁	Expository Method A ₂
height (B ₁)	A ₁ B ₁	A ₂ B ₁
low (B ₂)	A ₁ B ₂	A ₂ B ₂

The sample in this study was class A1 and A2 Primary Teacher Education (PTE) Student with 74 students. The research location was conducted in one university in the city of Cimahi. Sampling with simple random sampling technique. The sample was tested for the level of critical thinking skills, and the group was determined. The group's division is done by determining 27% of the low group and 27% of the high group.

Table 2. Number of Samples for Each Group

Ability Critical thinking	Lear Method	Experiment Method	Expository Method	TOTAL
		A ₁	A ₂	
height (B ₁)		10	10	40
low (B ₂)		10	10	
amount		20	20	

This research's procedures are as follows: 1) Preparation, including determining research samples, literature studies, making and testing instruments (instruments are compiled and validated before being tested in the field. These instruments are used in the pretest and posttest stages which are processed and analyzed using the assistance SPSS application 20. 2) Implementation, including giving a pretest to the experimental class and the control class. This is to measure students' critical thinking skills and initial learning outcomes in the two predetermined classes. Next, do the learning according to a predetermined schedule. When learning takes place, the researcher makes observations. After all, learning is conveyed, students are given a posttest to determine whether there is an increase in critical thinking skills and learning outcomes from the treatment that has been given during the previous meeting. 3) Evaluation, including collecting, processing, and analyzing data from the research that has been carried out.

The instruments used in this study were the critical thinking skills instrument and the observation sheet. The indicators of critical thinking skills include: building necessary skills, concluding, and providing further explanations.

Table 3. Differences in High and Low Critical Thinking Ability

High Critical Thinking Ability	Low Critical Thinking Ability
to quickly identify relevant information.	View all information as necessary.
Can use the information to formulate solutions to problems or make decisions	unable to grasp or think through the core problem.
Very sensitive and can distinguish ideas, ideas, conclusions.	Untested or untested assumptions easily influence them.
Think freely and are not afraid to disagree with other opinions from the group or society.	Tend to follow what the group or society says, follow the opinions or ideas of other people or groups without being critical.
Able to grasp the essence of a problem.	It is difficult to grasp the essence of a problem.

3. Result and Discussion

Results

The data analysis used was the analysis of the normality test and the homogeneity test. The normality test is used to determine whether the sample comes from a normally distributed population. Meanwhile, the homogeneity test was carried out to determine whether the population variance was homogeneous. After the results were obtained, the data were described using 2-way variance (ANAVA 2X2). The results can be seen in Table 4 and Table 5.

Table 4. Description of values

Learning methods Critical thinking	Learning methods			
	Experiment A ₁		Expository A ₂	
height (b ₁)	n ₁	10	n ₂	10
	∑x	235	∑x	179
	∑x ²	5567	∑x ²	3273
	mean	23,5	mean	17,9
low (b ₂)	n ₃	10	n ₄	10
	∑x	181	∑x	199
	∑x ²	3337	∑x ²	4005
	mean	18,1	mean	19,9

Table 5. ANOVA Results of the Interaction Between Learning Methods and Critical Thinking Ability to Science Learning Outcomes.

Source of Variance	DB	JK	RJK	F _{count}	F _{table}
between columns	1	36,1	36,10	5,93	4,11
between lines	1	28,9	28,90	4,75	4,11
interaction	1	136,9	136,90	22,48	4,11
in	36	219,20	6,09		
total reduced	39	421,1			

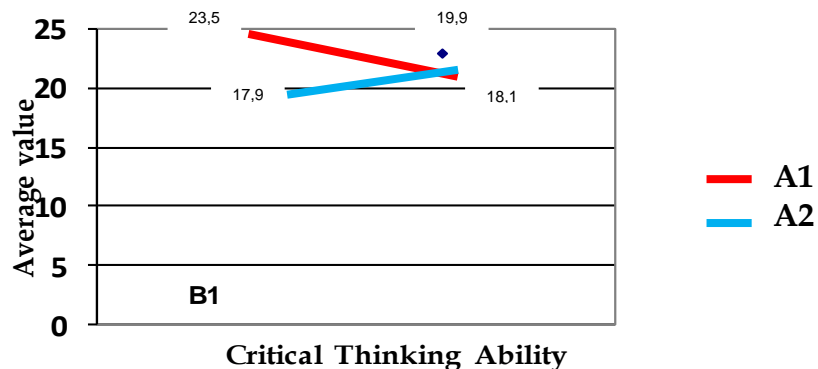
Based on the results of the analysis in Table 5, the following tests can be carried out.

Comparison of Science Learning Outcomes Between the Experimental Method (A₁) and the Expository Method (A₂)

The analysis results obtained F_{count} = 5.93 with F_{table} (0.05) = 4.11, then H₀ is rejected. This means that there are differences in science learning outcomes between using the experimental method (A₁) and the expository (A₂). In table 4, it can be seen that the average value of the group using the experimental method is 23.5, and the group using the expository method is 17.9. Thus, the results of learning science using the experimental method are higher than those using the expository method.

The Effect of the Interaction Between Learning Methods and Students' Critical Thinking Ability on Science Learning Outcomes.

The analysis results obtained that F_{count} = 22.48 at F_{table} (0.05) = 4.11, then H₀ is rejected. This means a significant interaction effect between learning methods and critical thinking skills on science learning outcomes. After knowing the effect of the interaction, the Tukey test was continued.



Graph 1. The Interaction between Learning Methods and Critical Thinking Ability to Science Learning Outcomes

Science Learning Outcomes Who Have High Critical Thinking Ability Using Experimental Method (A₁B₁) with Expository Method (A₂B₁).

Testing using the Tukey test shows the value of Q_{count} = 7.70 and Q_{table} = 2.04, then H₀ is rejected, meaning that there is a significant difference in science learning outcomes that have high critical abilities using the experimental method with the expository method or A₁B₁ > A₂B₁ because X A₁B₁ = 23.5 and X A₂B₁ = 17.9.

Science Learning Outcomes Who Have Low Critical Thinking Ability Using Experimental Method (A₁B₂) with Expository Method (A₂B₂).

The test using the Tukey test shows the value of Q_{count} = 2.47 and Q_{table} = 2.04, then H₀ is rejected, meaning that there is a significant difference in the results of learning science who have low thinking ability using the experimental method and those using the expository method or A₁B₂ < A₂B₂ because X A₁B₂ = 18.1 and X A₂B₂ = 19.9.

Discussion

The findings obtained in this hypothesis are that there is a significant difference in science learning outcomes between groups of students who study using the experimental method and the expository method. Student learning outcomes using the experimental method were higher than students learning using the expository method.

The use of experimental methods stimulates students to understand concepts and gain direct learning experiences related to scientific skills so that they can solve problems and foster critical thinking patterns. A study conducted by [Astuti et al. \(2015\)](#) and [Subekti & Ariswan \(2016\)](#) shows that experimental methods can improve learning outcomes and foster science process skills that can drive discovery and development of facts and concepts as growth and development of attitudes, insights, and values. In comparison, the expository method does not involve students in building their knowledge through skills and scientific activity processes so that any information conveyed by the lecturer is only included in the student's short-term retention. It causes learning to be meaningless for students. This is why the experimental method is more influential on student learning outcomes than using the expository method.

The Effect of the Interaction Between Learning Methods and Critical Thinking Ability on Science Learning Outcomes.

The statistical analysis of student science learning outcomes that are mutually influenced by two independent variables in this study, namely learning methods and critical thinking skills, causes an interaction effect.

In learning activities, an educator must have a good understanding of the use of learning methods, the more precise the method used, the more effective and efficient learning is. Lecturers must consider the learning objectives to be achieved, situations, and conditions, including students' critical thinking skills. Therefore, lecturers must be able to determine learning methods that are suitable for students' critical thinking abilities.

At this time, learning that prioritizes students' critical thinking skills has become a discussion topic ([Suparni, 2020](#)). These demands arise in line with the changing needs for workers' abilities in this technological era, including teachers. Teachers in this sophisticated era must possess various abilities that make them systems thinkers, problem solvers, independent decision-makers, and lifelong learners. The critical thinking skills trained in the PTE study program will later play a significant role for prospective teacher students in the decision-making process to solve problems in class when they become teachers.

Students who have high critical thinking skills will be able to view using the information to formulate problem solutions or make decisions ([Alfi et al., 2016](#); [Nurrohmi et al., 2017](#)). Meanwhile, students who have low critical thinking skills tend not to catch or think about the core problem of a problem. From this explanation, it can be concluded that the use of learning methods must be adjusted to the students' critical thinking skills. The result is that it can help in improving student science learning outcomes.

Differences in Science Learning Outcomes Given Treatment with Experimental Methods that Have High Critical Thinking Ability with Expository Methods Have High Critical Thinking Ability.

The hypothesis testing results show that the learning outcomes between groups of students who learn with the experimental method and have higher critical thinking skills are higher than the learning outcomes of groups of students who take learning with the expository method and have high critical thinking skills.

Students who have high critical thinking skills are susceptible and can distinguish between ideas, ideas, conclusions. They can interpret and evaluate information into an assessment or decision based on their abilities, knowledge, and experience. Besides, students who have high critical thinking skills have been trained in determining assumptions and implications in a systematic and orderly manner.

Students who have high critical thinking skills which are given treatment using experimental learning methods can easily understand the learning material. This is because, in the experimental learning process, students are allowed to experience or do it themselves, follow a process, observe an object, state, or process ([Arifin et al., 2016](#)). Furthermore, the experimental method can allow students to develop several skills and improve the quality of learning so that learning becomes more meaningful and learning outcomes increase ([Aziz et al., 2017](#)).

The application of this experimental learning process provides an opportunity for PTE students to find and find their answers to problems faced by carrying out their experiments, searching for truth, laws, or arguments, and drawing conclusions on the processes that have been carried out. This will cause students to become trained in scientific thinking and find evidence of the theory's truth about something they are studying ([Roestiyah, 2012](#)). The relevant research results also state that the application of

experimental methods in learning can improve student learning outcomes (Wahyuni et al., 2017; Juraini et al., 2017; Zender & Greiner, 2020), reasoning skills (Wachanga & Mwangi, 2004), and science process skills (Juraini et al., 2017).

Meanwhile, students who have high critical thinking skills which are given treatment with the expository method will experience obstacles in the learning process. In the expository method, students are asked to listen to the delivery of material verbally from the lecturer (Setyorini et al., 2013), it is hoped that they can capture the information that has been conveyed and be able to re-express what they have through the responses that have been given when asked questions. By the lecturer. The expository method is a method that combines lectures, questions and answers, and demonstration demonstrations by paying attention to the information presented verbally, taking notes, and doing practice questions. Although some opinions suggest that the expository method can provide students with meaningful learning, empirical studies in several studies do not always show significant results for the expository method. Research conducted by Hamilton-Ekeke (2007) shows that the field trip method has a more significant effect on students' ecological skills than the expository method. Learning outcomes also appear to have a significant effect on the application of the mind mapping learning method rather than the expository method (Widiari et al., 2014). The same thing can be seen from the research of Udo (2011) which shows that students' skills appear to be more improved with the Guided-Discovery method rather than the expository method.

Differences in Science Learning Outcomes of Students Given Treatment with Experimental Learning Methods who have low critical thinking skills with expository methods who have Low critical thinking abilities.

The results of further testing show that the results of student science learning between those who are given treatment with experimental learning methods with low critical thinking abilities are lower expository methods with low critical thinking abilities.

Students who have low critical thinking skills prefer simple learning and will experience difficulties if the learning process is dominated by a complex investigation process (Nugraha et al., 2017). They prefer a simple but fun learning process to feel comfortable and understand the learning material well. Furthermore, these students prefer a learning process that involves students actively in a predetermined task (Widiari et al., 2014). Students who have low critical thinking skills which are given treatment with the expository method can achieve success in learning because the learning process steps are more straightforward and easier to understand.

The use of the expository method makes it easier for students to understand learning material because in the expository method, the teacher provides material verbally and after that, students are asked to work on practice questions both individually and with their peers without conducting experiments and investigations that require students' reasoning abilities (Rachmawati, 2018). This makes students who have low critical thinking skills, who at first get bored quickly and are not enthusiastic about the learning process, become more active and improve their skills. Besides, these students will feel that they are in a comfort zone in the learning process, making them feel confident in the truth of the assignment given (Rosana, 2014).

Students who have low critical thinking skills who use the experimental method will experience difficulties in the learning process to decrease. One reason is that the experimental learning method requires students to test the truth of a theory through observation, measurement, and interpretation. For students who have low critical thinking skills, this can make them difficult because they cannot find the correct truth of a problem, carry out observational tests, interpret data to conclude. This finding is in line with research conducted by Gherardini (2016), which states that students who have low thinking abilities need the right learning approach to develop their abilities.

Another factor is the learning process step, which requires students to understand a problem in-depth to prove and draw conclusions. They cannot connect the knowledge they already have with the problems they face, so they cannot make conclusions by connecting one object to another.

4. Conclusion

Based on the above findings, it can be concluded that: 1). the influence of learning methods on learning outcomes of PTE students. 2). Students who learn using the experimental method get higher learning outcomes than students who learn using the expository method. 3). There is an interaction between the use of learning methods and the ability to think critically about the learning outcomes of PGSD students. 4). Shows the influence of the interaction between learning methods and the ability to think critically on PTE students' level of learning outcomes. Students who have high critical thinking skills

will have a better effect on student learning outcomes if students are taught using the experimental method. Conversely, PTE students who have low critical thinking skills will have a better effect on student learning outcomes if students are taught using the expository method.

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