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The contribution of cognitive ability and critical thinking skills on the problem solving skills of biology education profession students using case method learning

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ABSTRACT

Problem-solving skills have many benefits, especially for lifelong learning. Learners are equipped with these abilities to be able to survive in life and in their profession. Problem-solving skill is closely related to cognitive ability and critical thinking skill. This research aims at determining the contribution of students' cognitive ability and critical thinking skill on their problem-solving skill. This correlational research included 127 students taking education profession courses. The collected data were analyzed using correlation regression SPSS Version 23 software. The results of the data analysis showed that students' cognitive abilitys and critical thinking skills had a significant correlation with their problem-solving skills. The relative contribution of the cognitive ability and the critical thinking skill was 94.8%. While the effective contribution of cognitive ability and critical thinking skills toward the students' problem-solving skills was 68.4% and 26.4% respectively. The positive correlation among these variables can be used as a basis for implementing the case method in classroom learning activities in that the implementation of the case method has positive effects on the student's cognitive abilitys, critical thinking skills, and problem-solving skills in Biology Education students.

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INTRODUCTION

The students of Biology education department of Faculty of Teacher Training and Education (FKIP) of the University of Jember are prospective teachers. As prospective teachers, the Biology education students must learn how to teach students. In the education profession course is taught how to become a professional teacher. Lecturers not only teach learning material but also hone students' thinking skills (Fuad, 2020). This is in line with Yatim (2009) who explains that students' critical thinking skills need to be improved during learning activities, which will be beneficial for the students, especially in terms of the improvement of their problem-solving skills and so on.

Several learning models have been proven to be able to improve students' thinking skills, including experimental learning model (Gantina, 2016), guided inquiry learning model (Jayanti, 2018). Some of these learning models have proven to be able to improve students' thinking skills. Bahruddin (2016) also revealed that based on the results of observations and interviews in his research, it was proven that the case study method implemented during learning could improve students' critical thinking skills. This is related to the discussion method in the learning stages of case study. With discussion activities, students have the right to express their thinking skills, to deal with the problems faced and to have the freedom to express their problem solving skills. Furthermore, it was also explained that the learning using case method increased students' professionalism in learning because they were encouraged to come up with solutions of a particular case and to consider the good and bad effects if the solution was applied to the case. This is in line with Andayani's research (2022) reporting that as many as 87% of lecturers as respondents stated that case-based learning was able to increase student learning motivation.

Case method is a teaching method where the lecturers provide the students with a case to find the solutions (Anggraeni, 2012). The case can be provided from electronic news, newspapers, journal articles or other relevant sources related to the topic learned (Kusumawati, Kurniasari, & Khusniyah, 2019). The case method should be able to reduce the gap between theory and practice and able to provide complex and contextual learning experiences. Therefore, in case method learning, case articles will be presented to help students relate to the occurring phenomena, and it will be discussed in the discussion activities based on the results of students' observations and perspectives. Thus, the students not only memorize content but also find out the relationship between the learning material and the real world situation (Sakur & Mubarak, 2017). The students are expected to be able to develop their critical thinking skills and creativity in solving problems, to improve their enthusiasm and motivation in learning, the skills to communicate ideas, and the ability to cooperate with fellow group members to create a democratic atmosphere and respect each other's opinions (Wospakrik, Sundari, & Musharyanti, 2020).

Case-based learning, in previous research, has been proven to be able to improve students' cognitive abilities (Vahlepi, 2021). In his research, Vahlepi (2021) revealed that the case method learning was carried out by putting students into study groups and providing a case to solve. The involvement of students in groups can indirectly activate them. This has an impact on students' higher order thinking skills. Furthermore, it is explained that to produce quality thinking output requires a learning model that supports students' thinking skills, such as case-based learning. The characteristic of the case learning method is that the problem solving process is carried out and solved by team members. This characteristic requires the inclusion of a number of new variables, especially human factors. Therefore, the complexity of case method comes not only from the scale of the problem, but also from the complex interaction of cognitive, psychological, social, and behavioral interactions between group members during the problem-solving process (Lightner, Bober, & Willi, 2010).

Proven to be able to improve students' cognitive abilities in other studies, the case method is also able to improve students' critical thinking skills. This is in line with the research conducted by Andayani, et al. (2022) which reveals that the case method applied in learning significantly improved students' critical thinking skills, creative thinking skills and communication skills. It is further explained that the students taught by using case method learning will be able to collaborate with their group members and try to solve the problems given. These groups will produce the best solution, according to their group, by considering the good sides and bad sides of the solution offered. Students' critical thinking skills cannot be separated from their ability to think at a higher level. With the habituation of problem-solving, students can train their cognitive level to be even higher from time to time. This is in

line with research (Hodijah, et al., 2022) which proves that there is an increase in students' critical thinking skills with the application of the case method model.

Students will obtain complex learning experiences based on the methods provided by the educators during learning. One of the good learning methods to be implemented is the case method. Provided with several cases raised in learning, students have the opportunities to find solutions as an alternative for problem-solving. With such exercises, students are expected to empower their problem-solving skills maximally. Cognitive abilities, which include skills like critical thinking, reasoning, memory, and attention, are fundamental components of problem-solving. These abilities allow individuals to analyze complex situations, consider various perspectives, and generate creative solutions (Lamri, et al., 2023). Problem-solving often involves making decisions based on available information. Cognitive abilities influence how people process information, weigh pros and cons, and make informed choices. Understanding these connections can lead to improved decision-making processes (Banner, et al., 2008). This is in accordance with the research conducted by Fandi (2013) which explains that students' problem-solving can increase with the implementation of appropriate learning. Darma, et al (2019) also revealed that students' problem-solving can be improved through learning strategies.

Based on these views, the researcher conducted a study that aims to determine the correlation between cognitive ability and critical thinking skill variables with students' problem solving skill. By revealing the correlation between the three variables, it is expected to reveal that the implementation of case method learning can empower each variable to the maximum.

METHODS

Research Design

Research design of this study adopts a quantitative research design employing correlational research methods. It aims to investigate the relationships between various variables among students enrolled in the Biology Education study program at FKIP, University of Jember.

Population and Samples

The population of this research comprises all students within the Biology Education study program at FKIP, University of Jember. A subset of this population, specifically 127 students enrolled in the educational profession course, was selected as the research sample. These participants were chosen to represent the broader population under investigation.

Instrument

The instrument to collect research data, established and validated instruments were utilized. Cognitive ability tests, critical thinking skill tests, and problem-solving skill tests were employed to measure the relevant aspects among the research participants. The pretest and post-test results were evaluated using rubrics specifically designed for assessing cognitive learning outcomes, critical thinking skills, and problem-solving skills.

Procedure

The research was conducted in several stages. First, a sample of 127 students from the education professional course was selected. In the next stage, students underwent a cognitive ability test, a critical thinking skills test, and a problem-solving skills test. To conduct pretest and post-test assessments, customized rubrics for cognitive learning outcomes, critical thinking skills, and problem-solving skills were used. The research was conducted from one stage to the next to ensure the data collection was done correctly and the consistency of the assessment was maintained.

Data Analysis Techniques

For data analysis, this study used regression correlation test (inferential statistics) which was used to analyze the research data. Specifically, the multiple linear regression correlation test was conducted to examine the relationship between the variables under study. Data analysis was carried out with the aim of revealing the correlation between cognitive abilities, critical thinking skills, and problem solving skills of students. The IBM Statistics version 23 for windows program was used to assist in conducting data analysis, facilitating a more accurate and comprehensive exploration of the research results.

RESULTS AND DISCUSSION

Data normality test using Leven's test was conducted before hypothesis testing using multiple-

linear regression correlation test. The normality test results show that the research data is normally distributed. Hypothesis testing results can be seen in Table 1. The analysis results show the calculated F value of 1128.041 with a significance value of 0.000 or smaller than 0.05. This means that cognitive abilities and metacognitive abilities have a significant and positive correlation with students' problem solving skills.

Table 1.
ANOVA Test on the correlation between Cognitive Ability and Critical Thinking Skills with Student Problem-Solving Ability

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	8362.389	2	4181.194	1128.041	.000[b]
	Residual	459.618	124	3.707		
	Total	8822.007	126			
a. Dependent Variable: problem-solving						
b. Predictors: (Constant), Critical, Cognitive						

The results of the regression analysis (Table 2) show the contribution of cognitive abilities and metacognitive abilities towards problem-solving skills. The results of the regression test indicate that the multiple correlation coefficient (R) value is 0.974 with a determination value (R2) of 0.948. This means that cognitive abilities and critical thinking skills contribute 94.8% towards students' problem-solving skills.

Table 2.
Regression Analysis of Cognitive Ability and Critical Thinking Skills with Student Problem-Solving Skills

Model	R	R Square	Adjusted R Square	Std. An error in the Estimate
1	.974[a]	.948	.947	1.92525
a. Predictors: (Constant), Critical, Cognitive				

Table 3 shows that the relative contribution of cognitive ability towards students' problem-solving skills is 72.1%, and the relative contribution of critical thinking skills towards students' problem-solving skills is 27.9%. On the other hand, the effective contribution of cognitive ability and critical thinking skills towards students' problem-solving skills is 68.4% and 26.4% respectively. Thus, the total effective contribution is 94.8%, and the remaining 5.2% is the contribution of other factors. Thus, the cognitive ability variable has a bigger contribution towards students' problem-solving skills than the critical thinking skill variable does.

Table 3.
The Relative and Effective Contributions of Cognitive Ability and Critical Thinking Skills towards Student Problem Solving Skill

Variable	RC (%)	EC (%)
X1 (Cognitive)	72,1	68,4
X2 (Critical Thinking)	27,9	26,4
	100	94,8

Table 4 shows that the regression line equation for the correlation between cognitive abilities and critical thinking skills towards students' problem-solving skills is Y = -4.402 + 0.700X1 + 0.317X2. Based on the equation obtained, it can be seen that there is a positive correlation between cognitive abilities and critical thinking skills towards students' problem-solving skills. The higher the cognitive abilities and critical thinking skills are, the higher the problem-solving skills will be.

Table 4.
Coefficient of Regression Equation of Cognitive Ability and Critical Thinking Skills towards Student Problem-Solving Skills

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-4.402	1.728		-2.548	.012
	Cognitive	.700	.037	.712	18.804	.000
	Critical	.317	.041	.296	7.812	.000

a. Dependent Variable: problem-solving

The results of the data analysis reveal that there is a significant positive correlation between cognitive ability and critical thinking skill towards the problem-solving skills of the students taking the Education Profession course in the Biology Education Study Program, FKIP UNEJ. The effective contribution of cognitive ability and critical thinking skill variables towards problem-solving skills is 94.8%. Wang & Chiew (2008) explained that the basic human cognitive process is the ability to solve problems. The fact that the cognitive ability and the critical thinking skills have a significant and positive correlation towards problem-solving skills is in line with the research conducted by Lismayani et al, 2017; Sulianto, et al, 2018; Susilowati, et al. 2020.

Kusmanto (2014) revealed that a person's critical thinking skills will be able to improve his problem-solving skills. A person whose thinking skills are continually trained will develop a good habit to be able to deal with problems, both in the learning environment and in society. Yuwono (2016) explains that a person's problem-solving skills can help them solve everyday problems, which involves thinking activities. The thinking skills of a person will help the owner to adapt to various kinds of changes and be able to construct their thoughts.

Cognitive ability and critical thinking ability are abilities that are believed to have a correlation with problem solving skills. Cognitive abilities include a person's ability to be able to recognize, process information, store information, and retrieve information from the environment (Sudarma & Sukmana, 2021). A person's cognitive ability refers to the brain's ability to be able to process, analyze, and understand the information obtained. Students' cognitive abilities are very important because they are the basis for their ability to understand and master the concepts taught in various disciplines including those who will work as educators (Finn et al., 2014). Meanwhile, critical thinking skills involve a person's ability to be able to analyze, evaluate, and make logical and rational decisions (Ng et al., 2022). Critical thinking skills are used by a person to produce rational thinking, systematic, organized, and logical thinking in dealing with various problems or when faced with certain conditions or situations. This ability is very important for students because it will be able to help them solve problems and make the right decisions / solve problems in innovative ways (Changwong et al., 2018).

Several studies have shown that cognitive abilities and critical thinking skills have a positive relationship with problem solving skills. One of the studies conducted by Synder & Synder (2008) found that cognitive abilities and critical thinking skills are significantly related to problem solving skills in college students. These results indicate that the higher the cognitive ability and critical thinking skills, the better the problem solving skills. Cognitive ability can help a person gather information and analyze situations better. Meanwhile, critical thinking skills help in evaluating information and making the right decisions. Thus, someone who has good cognitive abilities and critical thinking skills will be able to overcome problems and find effective solutions.

However, it should be noted that problem-solving skills are also influenced by other factors such as learning motivation, learning experience, and their prior knowledge on a particular domain. In addition, problem-solving skills can also be honed and improved through a lot of practice and from various experiences experienced directly by students (Bariyyah, 2021).Thus, the problem-solving skills can be developed through various exercises and experiences that help individuals to develop their cognitive ability and critical thinking skills. Overall, the correlation between cognitive ability and critical thinking skills towards problem-solving ability has important implications in education and individual skill development. This shows that individuals can improve their problem-solving skills by developing cognitive ability and critical thinking skills (Nasriah, 2017).

Classroom learning should be able to activate the students. This can be achieved by providing

learning methods that suit the needs of the students (Arpizal, et al., 2021). Furthermore, it is stated that learning becomes less effective when only the lecturers are active while the students are not so active (passive). Therefore, lecturers have the duty of providing learning activities that activate the students. One of the learning activities that can activate students in learning is the case method. According to Aliusta and Özer (2016), students who are taught using Student-Centered Learning (CTL) will be able to increase their learning motivation, develop creativity in various ways and have the ability to learn independently. Furthermore, their research revealed that in addition to having a positive effect on motivation, creativity, and self-learning ability, it can also be used to improve students' cognitive abilities.

The case method is one of the learning methods that aims to improve students' cognitive abilities and critical thinking skills. This method requires students to understand a real case or scenario that requires critical analysis from the student, making an assessment of the problem at hand, and problem solving (Andayani et al., 2022). The case method can improve students' cognitive abilities so that it can stimulate their critical thinking. The case method requires students to study cases that are so complex and use their critical and analytical thinking to solve the problems of the case study presented. In this process, students are encouraged to be able to question and evaluate every aspect of the case they get and be able to identify the main problem, as well as find the right solution to the problem. Such activities can stimulate students' critical thinking and improve their ability to process and solve existing problems (Syam, 2022).

Learning with the case method is also proven to improve students' analytical skills. This is related to the cases given by educators will strengthen students' ability to analyze and understand the information obtained. To solve a case, students must analyze the information that has been available, find relevant facts and data and make reasonable conclusions. In this process, students develop their ability to process and interpret information (Hodijah et al., 2022).

Still related to students' critical thinking skills, learning with the case method is also related to students' ability to make decisions. Decisions are made to solve the case/problem they are analyzing. The case method can also help students develop critical thinking skills to make appropriate and effective decisions. Students are encouraged to evaluate the available options and choose the most rational option that they can use to solve the problem. In this process, students learn to make decisions based on available facts and relevant data, not just assumptions or personal views (Andayani et al., 2022).

Based on this, it can be clearly concluded that students' cognitive abilities affect their critical thinking skills and from these abilities will indirectly improve their ability to solve problems (Nasriah, 2017). The case method can help students in developing their ability to solve problems. Students must be able to consider factors related to the problem, evaluate available options, and choose the most effective solution to be carried out when solving the problem. In this process, students learn to solve problems systematically and analytically with the help of direction from educators of course (Gunawan et al., 2020).

In order to improve critical thinking and cognitive skills, the case method can be an effective and innovative alternative in the learning process. Case method not only helps students solve real problems, but also improves their ability to process and interpret information better, and make more rational and appropriate decisions (Syam, 2022).

Case method learning implemented in the Education Profession course in this research provides opportunities for students both in groups and individually to practice solving problems. Case method learning as a form of case-based learning will train students to deal with problems and find the best solutions from various points of view. The freedom to express their opinions, ideas and inspiration to find solutions will be able to train their thinking skills, both their cognitive abilities and their critical thinking skills

CONCLUSION

Based on the previous explanation, it can be concluded that there is a significant correlation between cognitive abilities and critical thinking skills towards problem-solving skills. The contribution of cognitive ability and critical thinking skills towards the students' problem solving skills is 68.4% and 26.4% respectively. Improving students' thinking skills during learning is very necessary for the success of students' learning. Further research can be carried out using predictor variables and criterion

variables. In addition, future research can investigate other learning method, instead of case method, to reveal the correlation between variables.

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