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Enhancing Students' Critical Thinking Skills: A Quasi-Experiment Study on Inquiry Learning Model

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ABSTRACT

Limitations of innovation in learning can cause problems, including the low critical thinking skills of students. Critical thinking skills are important in problem-solving activities, innovating, and being able to make decisions. Students' critical thinking skills can be improved through the inquiry learning model that focuses on finding new information or knowledge. This study aims to analyze the effect of the inquiry learning model on students' critical thinking skills using quasi-experimental research with research on the static-group comparison design. Data were collected from pre-research data (to determine the initial ability of students' critical thinking skills before treatment), pre-test, and post-test based on indicators of critical thinking skills. Statistical data were analyzed using prerequisite tests of normality test (Kolmogorov-Smirnov test), paired sample t-test (if the data is normal), homogeneity test (Levene's test), and the difference of critical thinking skills were measured using the independent sample t-test (if the data is normal) with SPSS. The results of the data analysis showed significant differences in the critical thinking skills of students participating in the inquiry learning model and conventional learning.

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In the recent 21st century, education has become an integral part of Indonesian culture (Sujana, 2019). It facilitates the transformation of behavior, critical thinking development, maturity process, humanizing, and increase of prosperity for a better future (Najmina, 2018; Nastiti et al., 2022). Therefore, educational processes, in both regular and non-regular learning, are essential for every learner, starting from primary school, secondary school, and university students (Fitri, 2021), to improve their competitive level in the 21st century (Mustofa et al., 2016). Competition is inseparable from the act of thinking, realized in the process of designing, innovating, problem-solving, and constructing new ideas (Rahayu et al., 2022). An individual's thinking skills influence their personality (Mamahit et al., 2020).

In addition, the 21st learning emphasizes student-centered learning (Falentina et al., 2020) in maximizing students' skills, such as critical thinking skills (Zubaidah, 2020). Critical thinking skill is defined as an individual's mental activities in formulating crucial events, followed by reasoning, decision-making, and idea representation (Fikriyatii et al., 2022). Besides, critical thinking also represents reasonable mental activity, thinking regulation, decision-making process, and impact analysis (Temel, 2022). Critical thinking is an essential skill for professional development (Morozova et al., 2022) since it aids someone in coordinating, speculating, predicting, evaluating, and constructing decisions (Nuryanti et al., 2018; Agnafia, 2019). This critical thinking skill is highly needed, primarily in the recent globalized world with more complex problems (Ramdani et al., 2022)

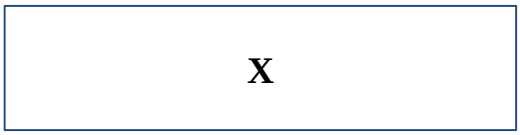
In the preliminary study, we used a pre-test involving 24 college students using the general essay test. The results of our preliminary study suggested that students still have a poor ability to answer those questions, as shown by their less critical answers. In measuring their critical thinking skills, we used a number of indicators, and the average scores for each indicator were 28.22, 29.89, 31.28, 32.62, and 29.78 for interpretation, analysis, inference, explanation, and evaluation indicators. The average scores for those indicators were 30.55, suggesting students' low critical thinking skills. These results indicated the need for teachers and educational staff to focus on enhancing students' critical thinking skills for their future development. Consequently, the classroom learning process should be examined. Ideally, classroom learning should not only use discussion and lecturing activities, but they should rather adopt a more meaningful learning model. A learning model directs the completion of a learning process, starting from the planning to the completion processes based on the learning stages (Kawuwung, 2012; Mamahit et al., 2020; Falentina et al., 2020). Learning completed using specific learning model have been reported to increase students' skills, including their critical thinking, creative thinking, collaboration, communication, argumentation, and problem-solving skills, as well as the learning motivation (cognitive, affective, and psychomotor) and scientific literacy (Hariadi et al., 202; Mursid et al., 2022; Qondias et al.,

2022). We have numerous available learning models, one of which is inquiry learning that facilitates students to improve their critical thinking abilities (Duran & Dökme, 2016; Hadi et al., 2018).

The inquiry learning model accentuates the identification of issues to be resolved (Juniati & Widiana, 2017; Nisa et al., 2018). The identification process involves the empowerment of the thinking process (Prasetiyo & Rosy, 2020). Through the stages of inquiry learning phases, students' potential can be developed, including critical thinking and other 21st-century life skills (Falentina et al., 2020; Zubaidah, 2020; Mamahit et al., 2020). Further, inquiry learning instructs students to investigate events, following the measured scientific methods and acceptable common knowledge (Adnan et al., 2021). Therefore, an examination of inquiry and conventional learning models is required to pinpoint their different influences on students' critical thinking skills.

METHOD

In this study, we used a quasi-experiment method with the static group comparison design. Therefore, we involved one large group from a class, which was later divided into two groups. The two groups were provided with treatments as the experiment and control groups. The static-group comparison design is illustrated in figure 1.



Description:
X = treatment
O1 = experiment group
O2 = control group

Figure 1. The Static-Group Comparison Design

The research was completed in one semester on a plant structure and development course in the Biology Education Department of Universitas Negeri Manado, involving 27 students. The participants were from one single class and divided into two groups during the learning process. During the learning, five meetings were conducted using the conventional learning model (lecturing, discussion, and students' project presentation), while the following five meetings were carried out using the inquiry learning model. Then, the essay test was given at the beginning of learning activities to the control and experiment groups. The test was in the form of an essay constructed based on the indicators of critical thinking skills.

For the research instruments, we used a test containing essay questions that were established according to critical thinking skill indicators, namely interpretation, analysis, inference, explanation, and evaluation. Before further analysis, we carried out the prerequisite tests, consisting of the normality test using Kolmogorov-Smirnov. Then, if the data were normally distributed, we conducted paired sample T-test and homogeneity test using Levene's test. After we gathered the normality and homogeneity of the data, if they had met the prerequisite, we measured different critical thinking skills among the students in the experiment and control groups using the independent sample T-test through SPSS.

RESULTS

Results of Prerequisite Tests on Students' Critical Thinking Skills

Normality Test

The obtained pre-test and post-test data were initially analyzed using the normality test. The data was deemed to have a normal distribution if the sig. > 0.05. The results of the data normality test on students' critical thinking skills are summarized in table 1.

Table 1. Results of Data Normality Test on Students' Critical Thinking Skills

	Group	Kolmogorov-Smirnov		
		Statistic	Df	Sig.
Critical Thinking Skills	Pre-test of experiment group (inquiry model)	.100	27	.200
	Post-test of experiment group (inquiry model)	.125	27	.200
	Pre-test of the control group (conventional model)	.128	27	.200
	Post-test of the control group (conventional model)	.116	27	.200

From the obtained results, the pre-test and post-test results of the experiment and control groups attained sig. > 0.05, with each group attaining sig. 0.200 > 0.05. Therefore, the pre-test and post-test from the experiment and control groups' data on critical thinking skills have a normal distribution.

Paired Sample T-test

After we identified that the data had normal distribution, we carried out paired sample t-test. Through the paired sample t-test, we identified the distinctions between the average pre-test and post-test scores. The results of paired sample t-test on critical thinking skills are shown in table 2.

Table 2. Results of Paired Sample T-Test on Students' Critical Thinking

Grup		Paired Differences					T	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pre-Test and Post-Test Scores from Experiment Group	-36.630	4.011	.772	-38.216	-35.043	-47.452	26	.000
Pair 2	Pre-Test and Post-Test Scores from Control Group	-12.741	3.879	.746	-14.275	-11.206	-17.068	26	.000

The results of paired samples t-test on pair 1, we obtained sig. (*2-tailed*) of 0.000 < 0.05. This finding signifies critical thinking skills differences between the pre-test and post-test results from the experiment group. On pair 2, we attained sig. (*2-tailed*) of 0.000 < 0,05, showing different average critical thinking skills between the pre-test and post-test of the control group.

Homogeneity Test on Students' Critical Thinking Skills

The homogeneity test was carried out after we finished the paired sample t-test. This homogeneity test was conducted to find students' different or various critical thinking skills. Before the independent sample t-test was completed, the data (pretest-posttest data from the experiment and control groups) should be homogeneous. The results of the homogeneity test are shown in table 3.

Table 3. Results of Homogeneity Test on Students' Critical Thinking Skills

		Levene Statistic	df1	df2	Sig.
Critical Thinking Skills	Based on Mean	.354	1	52	.555
	Based on Median	.313	1	52	.578
	Based on the Median and with adjusted df	.313	1	49.906	.578
	Based on trimmed mean	.369	1	52	.546

The homogeneity test results suggested sig. value based on a mean of 0.555 > 0.05, showing that the pre-test and post-test data from the control group were homogeneous. Therefore, the data analysis was continued using an independent sample t-test to find differences in students' critical thinking skills from the experiment and control groups.

Independent Sample T-test on Students' Critical Thinking Skills

As the prerequisite conditions had been met, we conducted an independent sample t-test to uncover the students' average critical thinking skills after they attended the inquiry and conventional learning. The results of the independent sample t-test are presented in table 4.

Table 4. Results of Independent Sample T-Test on Students' Critical Thinking Skills

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Critical Thinking Skills	Equal variances assumption	.354	.555	38.996	52	.000	24.333	.624	23.081	25.585
	Equal variances non-assumption			38.996	50.184	.000	24.333	.624	23.080	25.587

The analysis results shown in table 4 suggested equal variances assumption with sig. (*2-tailed*) of 0.000 < 0.05. This finding illustrates significant differences in critical thinking skills between the students attending the learning using inquiry and conventional learning models.

DISCUSSION

Inquiry learning includes collaborative activities (Sipayung et al., 2018) that facilitate individual thinking processes. Further, the ideas from that processes are further synthesized in a group to attain solutions for the problems (Brailas et al., 2017). With the inquiry model, the students can develop their critical thinking processes since it emphasizes activities focusing on finding solutions, ideas, and concepts to construct new knowledge (Caraballo & Lyiscott, 2020). The syntax of the inquiry learning model is orientation or observation, question or conceptualization, investigation, conclusion, and discussion or sharing (Bauld, 2022).

In the first syntax of orientation or observation, the lecturer introduces the learning topic while the students are permitted to explore the topic. Before the learning is carried out, the students are divided into six groups. Then, the students conduct collective observations on the complex issues provided in the learning process. In the initial observation, students are advised to gather important data or information for their further stages of investigation. The stage of observation aims to facilitate students' design a problem-solving scenario and strategy to resolve a problem in a group (Nisa et al., 2018). A learning focusing investigation and research phases develop students' thinking skills.

The second syntax is question or conceptualize, where students establish relevant questions on the topic of plant structure and development. Further, the questions are discussed in groups. Through this group discussion, students can find the answer. Also, students are directed to formulate a hypothesis to help them find accurate and relevant information. In the process of hypothesis and question formulation, students thinking develops since they propose ideas and notions through the reasoning phase (Hadi et al., 2018).

The third syntax is investigation. In this stage, students find various types of information and answer questions formulated in the previous stage. Collaboratively, these students search for information from relevant sources. Then, the collected information is consulted to build new and novel knowledge or concept. The investigation process obligates students to carry out the scientific processes in finding accurate information, equipping and training them to be a scientist (Rahmat & Chanunan, 2018).

In the fourth syntax (conclusion), students construct new knowledge based on their results of scientific investigation. Further, they also re-evaluate their hypothesis, whether accepted, rejected, or irrelevant. At this stage, the students have assembled new knowledge from a set of thinking processes consisting of designing a conceptual framework, gathering supporting data, hypothesis testing, data analysis, and evaluation. The garnered data and information are deemed to be valid and ready to be presented to other groups (Brailas et al., 2017). The constructed knowledge through scientific investigation is forecasted to benefit the expansion of sciences. Following these results, the students are asked to present their results of investigation to other groups, along with the question and answer session.

The last phase is discussion or sharing. After the lengthy information-gathering processes relying on students' critical thinking skills, they are facilitated to present their findings to other groups. The presentation is not completed in front of the classroom but by delegating one group member to another group in two cycles. The delegates deliver their group findings through PowerPoint media. Through this arrangement, the discussion runs smoothly, with the member actively listening to the presentation and asking questions. Besides, they are also facilitated to express their opinion freely and casually in exchanging knowledge gathered during the problem-solving process. After the first cycle of the presentation, the delegates move to another group and do the same presentation. This direct discussion aids students in expanding their social skills, self-confidence, ability to opine, and speaking skills while also helping them know each other (DeNoyelles et al., 2014). At the end of the discussion phase, the group member and delegate carry out a reflection on the material and knowledge they have learned.

In comparison, during conventional learning, students present their discussion results in front of the classroom. Globally, the discussion process is completed successfully. However, after a deep observation during the presentation, we found that the majority of students were not focused on listening to the presentation. They were busy writing, telling a story to friends, playing with their laptops or smartphone, and closing their eyes, as proven by only two or three students responding to the presentation. It signifies that the presentation in front of the classroom is less capable of motivating students' interaction, as their involvement in the question and answer session is low, with minimum ideas and opinions. Thus, they attain limited new knowledge at the end of the learning process. The same finding has also been reported by Ali & Mulu (2020), describing that during the student presentation in front of the classroom, many students do not focus on the presentation and present less involvement in the question and answer session. The study further proposed that the rotation presentation model, with a delegate moving and presenting to other groups, is more effective. Meanwhile, Prasetya et al. (2019) discovered that rotation presentation allows students to present responses and enhance self-confidence freely.

CONCLUSION

The obtained statistical data suggested significantly different average critical thinking scores from students attending inquiry learning and conventional learning. Therefore, the inquiry learning model carries more significant effects on critical thinking than conventional learning. Inquiry learning aids students in focusing on finding information and formulating ideas or

opinions to form new conceptual knowledge. Consequently, the inquiry learning model can be adopted in other courses to enhance and maximize college students' potential skills.

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