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The influence of the scaffolding approach on critical thinking skills and student collaboration on mathematics learning

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ABSTRACT

Students' critical thinking abilities and collaboration skills still need to be considered. To overcome the low critical thinking skills and encourage collaboration skills, innovative learning is needed by applying a scaffolding approach when mathematics learning takes place. Apart from critical thinking skills, students' collaboration skills must also be considered. This research aims to: 1) analyze the effect of the scaffolding approach on critical thinking skills, and 2) analyze the effect of the scaffolding approach on students' collaboration skills. This type of research is a pre-experiment with a one-group pretest-posttest design. The sample in this study was students in class VIII-C of SMP Negeri 1 Yogyakarta, totaling 32 students. Data collection techniques include tests, questionnaires, and observations. The analysis used is a paired t-test. The research results obtained are 1) learning with a scaffolding approach shows a significant difference in critical thinking abilities and collaboration skills as viewed from the pre-test and post-test results, and 2) learning mathematics with a scaffolding approach can improve students' critical thinking abilities and collaborative skills.

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Introduction

The 21st century causes every individual to have life skills to overcome the challenges that apply at that time, especially in the field of education. Based on the Decree of the Head of BSKAP Number 8 of 2022 concerning Learning Outcomes in Early Childhood, the Primary Education Level, and the Secondary Education Level in the Independent Curriculum states that some 21st-century skills in the field of knowledge can be developed through critical thinking skills and collaboration skills. Based on the Decree of the Head of BSKAP Number 8 of 2022 concerning learning outcomes on Learning Outcomes in Early Childhood, Primary Education Level, and Secondary Education Level in the Independent Curriculum stated that critical thinking skills are needed in various subjects, including mathematics and this is so that students can collect, manage and use the information that has been obtained. In other words, this ability can help students to solve a problem in a real context.

Facione (2011) stated that critical thinking skills consist of the ability to interpret, analyze, evaluate, and make a conclusion or the ability to make an explanation under information or mathematical concepts used to consider a decision. According to Firdaus et al. (2019), when students can think critically, they do not easily accept information and cannot easily make conclusions based on the information without a screening process to prove the truth of the information. Therefore, it can be concluded that critical thinking skills can help learners

to prove the truth of information through the process of interpretation, analysis, evaluation and finally deciding on a conclusion. Based on the previous explanation, it can be seen that critical thinking skills are very important for students to have, especially in mathematics learning. However, the results of research by Putri, Hoslin, & Efendi (2022) stated that the critical thinking ability of students in Indonesia is still in the low category. This is because students have not been able to work on problems or questions presented when the questions are different from the examples given so students find it difficult to develop their critical thinking skills.

In addition to critical thinking skills, collaboration skills are also needed in learning this century, especially in mathematics learning (Purba & Jailani, 2023). According to Friend & Cook (1992), collaboration skills can be viewed as a competent interaction in carrying out cooperation that aims to achieve goals that have been set together. Learning that aims to carry out collaboration can help students work effectively, improve their character, be responsible, combine information from various sources, train cohesiveness, and present valuable experiences (Ulhusna et al., 2020). It can be concluded that collaboration skills are skills in building mutual commitment in solving a problem or achieving a predetermined goal.

According to Chase et al. (2013), critical thinking skills and collaboration skills still need to be considered because they are two things that need to be confirmed through the learning process. Based on this, learning is needed that supports critical thinking skills and collaboration skills of students and the learning in question is learning with a scaffolding approach. According to Sunaryo & Fatimah (2020) and Purwanti et al. (2023), the scaffolding approach can create a learning environment that helps students optimize students thinking skills and collaboration skills. The steps for presenting material using a scaffolding approach according to Ji & Luo (2020), Reiser (2018), Pea (2018), Wood et al (1976) in Bernacki et al. (2020) include: (1) presenting material that is coherent, structured and not boring; (2) utilize technology platforms to implement learning; (3) present material that can support the self-reliance of students; and (4) present material under the initial knowledge of students. Therefore, several things must be considered when presenting material with a scaffolding approach, including the continuity of the material, the use of multimedia, and students' understanding of the material presented.

While it is acknowledged that critical thinking and collaboration skills are crucial for students, and the scaffolding approach is considered effective in improving these skills, there remains a lack of research on the specific impact of the scaffolding approach on students' critical thinking and collaboration in the context of math learning. Whereas Sunaryo and Purwanti et al have recognized that the scaffolding technique is beneficial for creating an effective learning environment, there is a dearth of empirical research examining the direct impact of this strategy on critical thinking and cooperation abilities. While several academics have provided an explanation of the stages involved in implementing the scaffolding strategy, it is important to conduct actual investigations to ascertain its true influence on students' mathematical learning ability. We conducted this research to investigate the impact of scaffolding techniques on the development of critical thinking and collaboration skills in the field of mathematics education.Therefore, this research aims to analyze the effect of the scaffolding approach on students' critical thinking and collaboration skills in mathematics learning.

Method

This type of research is pre-experimental research, which is research that only involves one group or one class as an experimental and treatment class. This study used a group pretest-posttest design. Before the study, students in the class were given pretests, and after the research were given postes (Lestari & Yudhanegara, 2015). The purpose of this study is to see whether there is an influence of the scaffolding approach on students' critical thinking skills and collaboration in mathematics learning. The population in this study was all grade VIII students of SMP N 1 Yogyakarta. Purposing sampling is the sampling method used. Therefore, class VIII-C which amounted to 32 people was selected as a research sample based on input from class VIII mathematics teachers. Observation sheets, collaboration questionnaires, and critical thinking skills tests were used as data collection methods. The data collected are pretest and posttest data. Prites data were taken before carrying out learning with a scaffolding approach while postes data were taken after carrying out learning with a scaffolding approach. The questions used are 5 points of description questions and the collaboration questionnaire consists of 20 points of statements with the following assessment criteria.

Table 1. Critical thinking skills assessment criteria

Interval Nilai	Criterion
$90 \leq X \leq 100$	Very high
$80 \leq x < 89$	Tall
$70 \leq x < 79$	Keep
$60 \leq X < 69$	Low
$X < 60$	Very low

Formula:

$$x = \frac{skor\ yang\ diperoleh}{skor\ maksimum} \times 100$$

Information:

X= value earned by students

Table 2. Collaboration assessment criteria

Interval Skor	Criterion
$X > 135$	Very high
$105 < X \leq 135$	Tall
$75 < X \leq 105$	Keep
$45 < X \leq 75$	Low
$X \leq 45$	Very low

Information:
X= *total* score

Before determining the assessment criteria, first, pay attention to the scoring guidelines both on questions and questionnaires. Here are the scoring guidelines used in this study.

Table 3. Question scoring guidelines

Score	Information
2	Overall correct answer
1	Almost the correct answer overall
0	Blank or wrong answer

Table 4. Poll scoring guidelines

Statement Score		Information
+	-	
5	1	Agree
4	2	Agree
3	3	Simply agree
2	4	Disagree
1	5	Strongly disagree

Test the hypothesis of the effect of the scaffolding approach on critical thinking skills and collaborative skills using the help of SPSS with the test *Paired sample t-test*. The hypotheses in this study are:

For critical thinking skills:
H0: There is no significant difference in the pretests and posts of students' critical thinking skills using the scaffolding approach.
H1: There are significant differences in students' critical thinking skills using a scaffolding approach.

For collaborative prowess:
H0: There was no significant difference in the pretests and posts of students' collaborative skills using the scaffolding approach.
H1: There are significant differences in the pretests and posts of students' collaborative skills using the scaffolding approach.

The decision-making criterion is when the significance is <0.05 or α then H0 is accepted or when the significance > 0.05 or α then *H0 is rejected.*

Results and Discussions

This mathematics learning innovation using a scaffolding approach was carried out to see if there was a significant influence on students' critical thinking skills and collaboration skills. Before conducting the trial, researchers conducted validation tests on lesson plans, learning media in the form of power points, critical thinking ability test instruments and collaboration skills questionnaires. This study was conducted for 5 meetings. The percentage of its implementation is shown in table 5.

Table 5. Percentage of Implementation of Learning Activities

Meeting to-	Learning Implementation Percentage	
	Teacher Activities (%)	Student Activities (%)
1	74	74
2	93	93
3	96	96
4	100	100
5	100	100
Average	92,6	92,6

Based on Table 5, it is known that mathematics learning with a scaffolding approach is carried out very well. The percentage of good learning implementation in terms of teacher and student activities is getting better and better. The results of pretests and posts on students' critical thinking skills are presented in Tables 6 and 7.

Table 6. Results of analysis of students' critical thinking skills

Information	Critical Thinking Skills	
	Pretes	Posts
Average	32,86	86,63
Standard deviation	5,89	5,71
Score maximum	44	96
Score minimum	20	76
Number of learners	32	32

Table 7. Results of student collaboration skills analysis

Information	Collaboration Skills	
	Pretes	Posts
Average	107,75	127,38
Standard deviation	2,38	4,67
Score maximum	114	137
Score minimum	104	117
Number of learners	32	32

Before looking at whether or not there is an influence of the scaffolding approach on students' critical thinking skills and collaboration skills, the first step is to conduct a normality test. The normality test results are presented in Table 8.

Table 8. Normality Test Results

	Kolmogorov-Smirnova		
	Statistic	df	Say.
PretestCritical Thinking	.152	32	.059
PostesCritical Thinking	.143	32	.093
PretesCollaboration	.124	32	.200*
PostesCollaboration	.134	32	.151

The significance value of all tests is more than 0.05 or α which means that all data are normally distributed. The second step, perform the test *paired sample t-test* on the critical thinking ability of learners. Test results *paired with sample t-test* on learners' critical thinking skills are presented in Table 9.

Table 9. Paired *sample t-test results* on critical thinking skills

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	PretesCritical Thinking - PostesCritical Thinking	-53.750	7.666	1.355	-56.514	-50.986	-39.661	31	.000

Based on Table 6, the average pretest is 32.86 with a standard deviation of 5.86. While the average postes were 86.63 and the standard deviation was 5.71. Based on Table 9, the Significance value is 0.000 so the value is less than α=0.05 so H0 is rejected. So the conclusion that can be drawn is 'There are significant differences in pretests and posters of students' critical thinking skills using a scaffolding approach'. The third step is to conduct *a paired sample t-test* on the collaborative skills of students. The paired *sample t-test results* on students' collaborative skills are presented in Table 10.

Table 10. Paired *sample t-test results* on collaborative skills

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	PretesCollaboration - PostesCollaboration	-19.625	5.053	.893	-21.447	-17.803	-21.971	31	.000

Based on Table 7, the average pretest is 107.75 with a standard deviation of 2.38. While the average postes were 127.38 and the standard deviation was 4.67. Based on Table 10, the Significance value is 0.000 so the value is less than α=0.05 so H0 is rejected. So the conclusion that can be drawn is 'There is a significant difference in the pretests and postes of student collaboration skills using the scaffolding approach'. Based on the results of the analysis that has been carried out, it illustrates that there is a significant influence on mathematics learning using a scaffolding approach on students' critical thinking skills and collaborative skills. Analysis of students' critical thinking skills can be reviewed in Table 6 while analysis of students' collaboration skills can be reviewed in Table 7. Based on Table 6, it is known that there is an increase in the average critical thinking ability of students after carrying out mathematics learning with a scaffolding approach. This is in line with the results of Sunaryo's research (2020) which states that the scaffolding approach can improve students' critical thinking skills. Based on Table 7, it is known that there was an increase in the average proficiency of student collaborators after carrying out mathematics learning with a scaffolding approach. This is in line with the results of research by Diawati, Abdurrahman & Jalmo (2023) which states that scaffolding can help students optimize their collaboration skills.

The advantages of the scaffolding approach can create supportive learning activities, and train independent students to solve problems slowly. When students begin to be independent in learning can create mutual trust between group mates to solve problems without relying on many explanations from the teacher. In the course of the scaffolding process, students and teachers actively participate in social interaction to cultivate a collective comprehension of the activity and its objectives. Teachers progressively foster students' critical thinking abilities and subsequently diminish their support by assigning them more responsibility. The ability of students to effectively integrate prior information with new knowledge is a reliable measure of the effectiveness of the learning process. As stated by Kurniasih (2012), scaffolding can be implemented through modeling desired behaviors, offering explanations, inviting student participation, verifying and clarifying student understandings, and inviting students to contribute clues.

Conclusions

Based on the results and discussion of this study related to mathematics learning with a scaffolding approach, it can be concluded that: 1) learning with a scaffolding approach shows a significant difference in critical thinking skills and collaboration skills in terms of the results of pretests and postes, 2) mathematics learning with a scaffolding approach can improve students' critical thinking skills and collaborative skills. Learning with a scaffolding approach can be an alternative learning for teachers, especially to improve students' critical thinking skills and collaboration skills in mathematics learning. For further research, it can develop more interactive learning media to further optimize students' critical thinking skills and collaboration skills in mathematics learning.

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