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Think talk write and critical thinking in biology education

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ABSTRACT

The 21st century is characterized by rapid change, innovation, and increasingly intense globalization. This condition demands individuals to have skills capable of facing various challenges. One of the skills that need to be possessed is critical thinking skills. Critical thinking skills are important for students to help in analyzing problems, evaluating, and identifying solutions to complex problems. The results of observations that have been carried out indicate that students' thinking skills are still not optimally developed. Steps that can be used are implementing cooperative learning Think Talk Write (TTW). The aim of this study was to determine the effect of the cooperative learning model Think Talk Write (TTW) on the critical thinking skills of class XI MIPA students at SMA Negeri 3 Enrekang. The design of this study was a one-group pretest-posttest design. The research instruments used were a critical thinking skills test and a student activity observation sheet. Data were analyzed using descriptive statistical analysis and inferential statistical analysis using the Paired Sample Test. The results showed that the average pre-test score of students' critical thinking skills was 35.25 in the "very low" category and the post-test score was 77.58 in the "high" category. The results of the statistical analysis obtained a probability value of sig (2-tailed) = 0.000 <α (α = 0.05). These results indicate that learning using the Think Talk Write (TTW) cooperative learning model has an effect on the critical thinking skills of Class XI MIPA students at SMA Negeri 3 Enrekang.

INTRODUCTION

Rapid technological development, globalization, and the massive availability of digital information require educational reform that prepares students not only to master subject content but also to think critically, evaluate information, communicate ideas, collaborate, and solve problems in real-life contexts (Thornhill-Miller, 2023, & Zhao et al., 2024). In the framework of 21st-century learning, critical thinking is positioned as one of the core competencies alongside creativity, communication, and collaboration (Thornhill-Miller, 2023 & Lin., 2023) In science learning, this skill is particularly important because students are expected to interpret data, examine evidence, analyze causal relationships, distinguish facts from opinions, and draw logical conclusions based on scientific reasoning (Hasiyatiningsih, 2025 & Mueller et al., 2020) Therefore, science learning should move beyond memorization and teacher-centered instruction toward learning experiences that actively engage students in inquiry, discussion, argumentation, and reflective writing.

Critical thinking refers to students' ability to access, analyze, synthesize, interpret, and evaluate information to make reasoned judgments and solve problems (Hasiyatiningsih, 2025, & Zhang et al.). Students with strong critical-thinking skills can question the accuracy of information, examine alternative explanations, present evidence-based arguments, and make rational decisions. However, these skills do not develop automatically; they need to be developed through appropriate learning models, meaningful tasks, and classroom environments that encourage students to express ideas, respond to different perspectives, and justify their reasoning (Lin et al., 2023; Mueller et al., 2020). This is in line with the demands of 21st-century education, which emphasizes developing students' ability to think independently, collaborate with others, and use information responsibly (Mueller et al., 2020; Mohamed, 2021).

Preliminary observations and interviews conducted at SMA Negeri 3 Enrekang indicated that students' critical thinking skills were still underutilized and remained in the low category. Students tended to use their mobile phones to search for direct answers on the internet without critically analyzing the information obtained. In classroom activities, students were often passive, less confident in expressing opinions, and rarely provided arguments or evidence when responding to questions. Science teachers also reported that students were not sufficiently trained to identify problems, analyze information, evaluate ideas, and formulate conclusions. This condition indicates that the learning process has not optimally facilitated students' active participation and critical reasoning (Inganah et al., 2023). If this situation continues, students may become dependent on instant information and have difficulty developing scientific reasoning, problem-solving ability, and independent learning habits.

One learning approach that has the potential to overcome this problem is cooperative learning, particularly the Think-Talk-Write (TTW) model. Cooperative learning has been reported to support the development of critical thinking by providing opportunities for students to interact, exchange ideas, discuss different perspectives, and construct understanding through social interaction (Silva et al., 2022; 2023; Bustami et al., 2019; Nasruddin et al., 2022). The TTW model consists of three main stages: think, talk, and write. In the think stage, students process information individually, identify problems, and organize initial ideas. In the talk stage, students discuss their ideas with peers, compare arguments, and clarify understanding. In the write stage, students express their reasoning in writing, allowing them to organize concepts, formulate conclusions, and reflect on their learning (Hasiyatiningsih et al., 2025; Zhang et al., 2025; Listiana et al., 2023; Safitri & Jayanti, 2023). These stages are relevant to the development of critical thinking because they require students to analyze information, communicate arguments, evaluate ideas, and construct written explanations.

Several previous studies have shown that cooperative learning and TTW-based strategies can improve students' thinking skills. Silva et al. found that cooperative learning structures were more effective than traditional teaching in developing students' critical thinking skills, including observation, interpretation, analysis, and argumentation (Silva et al, 2022). Another study reported that cooperative learning through Jigsaw and Group Investigation was more effective than lecture-based learning in promoting critical and creative thinking (Silva et al, 2023). In the context of science and biology learning, Bustami et al. showed that the TTW model, assisted by picture cards, significantly improved students' critical thinking skills on the human digestive system material (Bustami et al., 2019). Similarly, the Group Investigation, integrated with the think-talk-write strategy, was found to positively affect students' critical thinking and collaboration skills in biology learning (Nasruddin et al., 2022). These

findings indicate that TTW has strong pedagogical potential; however, empirical evidence regarding its implementation for Grade XI MIPA students at SMA Negeri 3 Enrekang remains limited.

Based on the previous explanation, the novelty of this study lies in examining the effect of the Think Talk Write cooperative learning model on the critical thinking skills of Grade XI MIPA students in the specific context of science learning at SMA Negeri 3 Enrekang. Unlike previous studies that mostly examined TTW across different educational levels, subject areas, or learning materials, this study focuses on using TTW to address students' low critical-thinking skills identified through preliminary classroom observations and teacher interviews. The urgency of this research stems from the need to develop a learning model that reduces students' passive learning habits, encourages evidence-based reasoning, and trains students to think, discuss, and write scientifically. Therefore, this study aims to examine whether the Think Talk Write cooperative learning model has a significant effect on the critical thinking skills of Grade XI MIPA students at SMA Negeri 3 Enrekang. The research question formulated in this study is: Does the Think Talk Write cooperative learning model significantly affect the critical thinking skills of Grade XI MIPA students at SMA Negeri 3 Enrekang?

METHODS

Research Design

This study employed a quantitative approach with a pre-experimental design using a one-group pretest-post-test model (Creswell, 2014). This design was used to examine the effect of the Think Talk Write (TTW) cooperative learning model on students' critical thinking skills by comparing their scores before and after the treatment. In this design, the same group of students was given a pretest before the implementation of the TTW model and a post-test after the treatment. The one-group pretest-post-test design is presented in Table 1.

Table 1.
One-Group Pretest-Post-test Research Design

Before	Rubric treatment	After
O1	X	O2

Description:
O1 = pre-test before treatment
X = treatment
O2 = post-test after treatment

Table 1 shows that students' critical thinking skills were measured before and after the implementation of the TTW cooperative learning model. The comparison between pretest and posttest scores was used to determine whether students' critical thinking skills improved after the treatment.

Population and Samples

The population of this study was the eleventh-grade science students at SMA Negeri 3 Enrekang. The sample was selected using a random sampling technique. The research sample consisted of 29 students, including 14 males and 15 females. The demographic data of the research sample are presented in Table 2.

Table 2.
Demographic Data of the Research Sample

Gender	Number of Students	Percentage
Male	14	48.28%
Female	15	51.72%
Total	29	100%

Table 2 shows that the research sample comprised 29 students, including 14 males and 15 females. The presentation of demographic data provides a clearer description of the participants involved in this study.

Instrument

The instruments used in this study consisted of observation sheets and a critical thinking skills test. The observation sheet was used to document the implementation of the Think-Talk-Write

cooperative learning model during the learning process. Meanwhile, the critical thinking skills test was used to measure students' critical thinking skills before and after the treatment.

The critical thinking skills test was developed based on critical thinking indicators adapted from Ennis (Ennis, 1996), including the ability to provide simple explanations, build basic skills, draw conclusions, provide further explanations, and determine strategies or actions. This test consists of 10 essay questions. Each answer is scored using a critical-thinking rubric on a 1–4 scale, with higher scores indicating better critical-thinking performance.

The validation results indicated that the research instrument was valid and suitable for data collection. The first validator assessed that the instrument could be used with minor revisions, while the second validator stated that the instrument could be used without revisions. After improvements were made based on the validators' suggestions, the instrument was deemed to meet content validity criteria and was ready for use in the research phase.

Procedure

The research was conducted in several stages: preparation, pretest, treatment, posttest, and data analysis. The research procedure is presented in Figure 1.

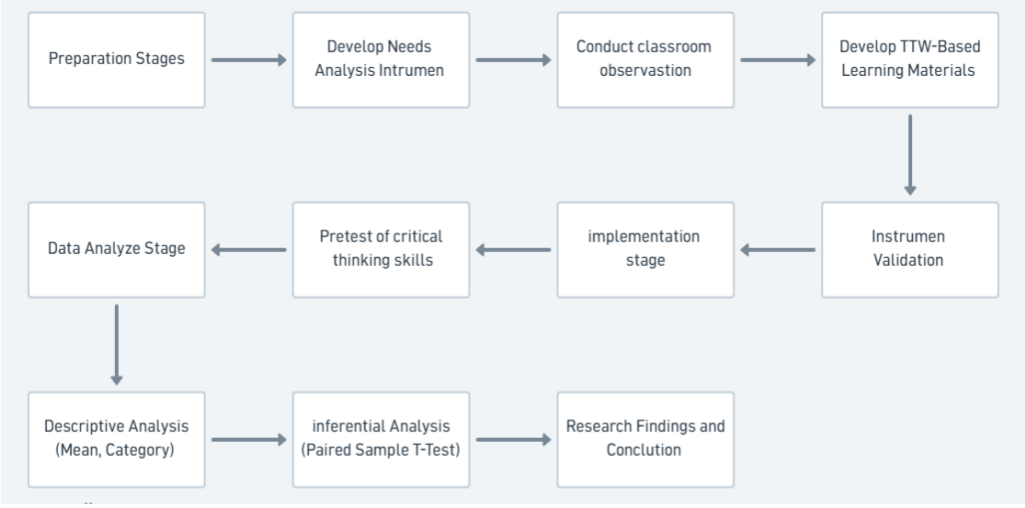

Figure 1. Research Procedure

Figure 1 shows the stages of the research procedure. The research procedure began with the preparation stage. This stage began with developing the needs-analysis instrument, conducting observations, developing learning tools in accordance with the TTW learning steps, and validating the instruments prior to use. The second stage was implementation. This stage involved implementing the prepared learning design. Before implementing the learning, a pretest was conducted. The pretest was conducted to assess students' initial critical thinking skills. The learning process is carried out over four meetings. After implementing the TTW model in the learning process, a post-test is conducted to see changes in students' critical thinking skills. The third stage is data analysis. The pre-test and post-test data obtained are then analyzed to assess the results of the research conducted.

Data Analysis Techniques

The data obtained from the pretest and post-test were analyzed quantitatively. Descriptive statistics were used to describe students' critical thinking skills before and after the treatment, including the mean, minimum, maximum, and standard deviation. Before hypothesis testing, a normality test was conducted. The significance level used in this study was 0.05. The TTW cooperative learning model was considered to have a significant effect on students' critical thinking skills if the significance value was lower than 0.05.

RESULTS AND DISCUSSION

The results of this study showed an increase in students' critical thinking skills following the implementation of the Think-Talk-Write (TTW) cooperative learning model. The average pretest score was 35.25, while the average post-test score increased to 77.58. The comparison of students' average

critical-thinking skill scores before and after the implementation of the TTW model is presented in Figure 1.

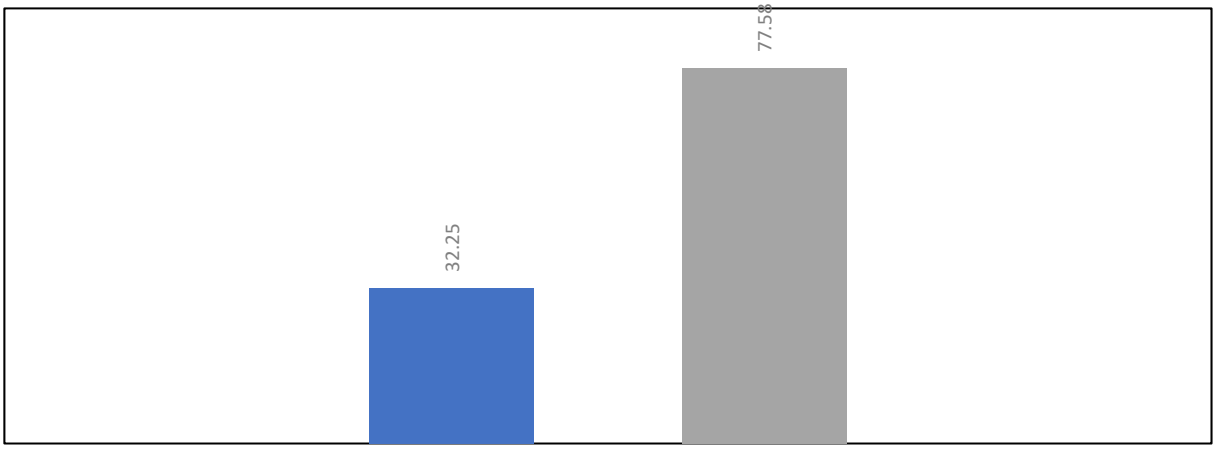

Figure 2. Average critical thinking skills of students

Figure 1 shows that students' average critical thinking score increased by 42.33 points after implementing the TTW cooperative learning model. This increase indicates that students demonstrated improved performance in analyzing information, formulating arguments, drawing conclusions, and presenting ideas after participating in learning activities aligned with the TTW stages. The low pretest score suggests that before the treatment, students were not yet accustomed to using critical reasoning when responding to scientific problems. In contrast, the higher post-test score indicates that the TTW model provided learning opportunities that encouraged students to think independently, discuss ideas collaboratively, and organize their reasoning in writing. The descriptive results were further supported by an inferential statistical analysis using a paired-samples t-test. The results of the paired sample t-test are presented in Table 3.

Table 3.
Statistical analysis results

	Paired Difference					T	Df	Sig. (2-taild)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Data Posttest-Pretest	42.3276	7.5573	1.4033	39.4530	45.2022	30.162	28	.000

Table 3 shows a statistically significant difference between students' pretest and posttest scores ($p < 0.001$), indicating a significance level below 0.05. This result indicates that the null hypothesis was rejected, and the alternative hypothesis was accepted. Therefore, implementing the TTW cooperative learning model was associated with a significant increase in students' critical thinking skills. The confidence interval also indicates that the increase in scores was consistently positive, indicating that post-test scores were higher than pretest scores after the treatment.

The improvement in students' critical thinking skills can be interpreted through the learning syntax of the TTW model. Each stage contributes to different aspects of critical thinking. The Think stage provides students with opportunities to read, observe, identify problems, and independently construct an initial understanding. At this stage, students are encouraged to process information, distinguish relevant and irrelevant data, and formulate preliminary ideas before discussing them with peers. This activity is closely related to the critical thinking indicators proposed (Ennis, 1996), particularly the ability to provide simple explanations, build basic skills, and draw conclusions. Previous studies also emphasize that individual thinking activities prior to discussion can strengthen students' metacognitive awareness and help them monitor their understanding (Beronilla & Natividad, 2025).

The first stage is Think. The thinking stage is evident in the activity of reading texts and is an initial knowledge-gathering activity. After reading, students take brief notes in their own language, noting what they have understood, what they have not understood, and how to solve problems (Wu H & Molnár G, 2022). This process trains students to understand independently (Djibran A et al, 2025). Previous research shows that active reading and reflective note-taking during the Think stage contribute to improved critical thinking skills (Asnawi et al., 2025). When students are asked to identify important information, mark parts they do not understand, and plan problem-solving strategies, they are indirectly trained to think systematically and analytically. This is in line with findings from various studies indicating that early cognitive involvement in cooperative learning plays an important role in improving the quality of discussion and subsequent learning outcomes.

The thinking process also plays a role in training students' analytical skills (Demir, 2022). In this phase, students are given the opportunity to read, observe, or understand the problems presented individually. This activity requires students to identify key information, connect related concepts, and map out the structure of the problem independently (Fries et al, 2021). Analytical skills emerge when students begin to distinguish between relevant and irrelevant information, group ideas, and formulate initial problem-solving alternatives. Theoretically, this phase is very important because analysis is the foundation of critical thinking, enabling students to develop more mature arguments and explanations in the next stage (Loyens et al., 2023). The students' thinking process occurs when they answer the questions in the LKPD individually before entering the talk stage. In the thinking process, students are given the opportunity to think about the material or to answer questions posed by the educator in the form of worksheets, which are completed individually (Harwati, Rokhmat J, 2021).

The second stage is Talk. In this stage, students are organized into several heterogeneous groups. Each group consists of 3-5 students. The purpose of heterogeneous grouping is to encourage students to work together, share responsibilities, and learn from each other (Beronilla & Natividad, 2025). In addition, grouping is also done to increase student participation and motivation. The talk stage also trains students to discuss in small groups to compare their thoughts, assess the accuracy of arguments, and test the strength of the evidence used (Djibran et al, 2025). Interaction in the talk stage stimulates the evaluative process because students need to consider their friends' opinions, clarify differences in perception, and assess the validity of an argument. This activity directly encourages students to evaluate the quality of the information they use and test the logical consistency of the reasoning that develops within the group. The evaluation that arises during the discussion will help students build more rational knowledge. In accordance with the critical thinking skill indicator of evaluation, students write down the ideas, concepts, information, and opinions that they will include in the LKPD. This process trains students to explain their reasons and reasoning clearly and in a structured way. These ideas have been discussed and evaluated together. Thus, the Talk stage plays an important role in building students' critical thinking skills through an evaluative and argumentative process based on collaboration (Cui, 2023)

Final activity: Write. In this stage, participants will write down the results of the discussion. Writing activities help participants develop ideas in writing. This stage also trains students to transform knowledge into new representations. In this stage, students' inference skills are trained as they draw conclusions based on the evidence, arguments, and ideas discussed together. Inference is a critical-thinking process that requires students to draw reasonable generalizations, formulate justifiable assumptions, and make decisions based on the data obtained (Manolescu, 2024). This stage involves writing down the ideas and opinions that have been expressed and discussed with group members. Interaction and discussion between groups will actively involve students in learning and can develop their mindsets (Muenks et al, 2021). People absorb information more quickly through what they hear, through speech, discussion, tone of voice, talking about things, and listening to what others say (Chen, 2021). Information obtained through this process will be reinforced when it is reconstructed in writing, thereby supporting the overall improvement of students' critical thinking skills.

The results of this study support previous findings related to the effectiveness of TTW in science and biology learning. Bustami et al. reported that the TTW model, assisted by picture cards, significantly improved students' critical thinking skills on the human digestive system (Bustami et al., 2019). Integrating Group Investigation and Think Talk Write in biology classrooms could empower students' metacognitive skills, which are closely related to critical thinking processes (Listiana et al., 2020). These findings strengthen the argument that TTW is effective because it combines individual cognitive

processing, collaborative discussion, and reflective writing. In the context of this study, the increase in students' post-test scores indicates that the TTW model helped students become more active, reflective, and systematic in solving learning problems.

From a pedagogical perspective, implementing TTW shifts the learning process from teacher-centered instruction to student-centered learning. Before the treatment, students tended to depend on direct answers and were less active in expressing ideas. After the treatment, students were trained to examine information independently, discuss their reasoning with peers, and write conclusions based on the results of group discussion. This learning process is important in science education because critical thinking cannot be developed only through memorization or passive listening. Students need repeated opportunities to analyze problems, evaluate evidence, communicate arguments, and reflect on their own thinking processes.

CONCLUSION

The findings of this study indicate that the Think Talk Write (TTW) cooperative learning model improved critical thinking skills among Grade XI MIPA students at SMA Negeri 3 Enrekang. This improvement was evidenced by an increase in students' average score from 35.25 on the pretest to 77.58 on the posttest, as supported by the paired-samples t-test, which showed a significant difference at $p < 0.001$. These findings suggest that the TTW model provides students with meaningful learning experiences through the stages of thinking individually, discussing ideas collaboratively, and writing conclusions systematically. The implication of this study is that the TTW cooperative learning model can be used as an alternative learning strategy to promote active, reflective, and student-centered science learning. For teachers, this model can help reduce passive learning and encourage students to analyze information, articulate arguments, evaluate ideas, and construct written explanations grounded in scientific reasoning.

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