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Bridging cooperative learning and scientific approach: Enhancing critical thinking in middle school biology through numbered heads together

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ABSTRACT

Critical thinking skills help students understand concepts and recognize problems. The scientific approach is highly relevant to biology instruction; however, its group stages are often dominated by a few students because no mechanism ensures that every member is accountable for the group's scientific work. Numbered Heads Together (NHT), a cooperative learning model, may complement the scientific approach by providing a structured framework for collaborative learning and individual accountability. This study analyzed the effect of NHT integrated with the scientific approach on junior secondary students' critical thinking skills on the plant reproductive system. This quasi-experiment used a pretest-posttest control group design with 60 ninth-grade students from SMPN 7 Kota Ternate (experimental group) and SMP Nasional Banau Kota Ternate (control group, scientific approach without NHT). The study was conducted from March to May 2026 (even semester, 2025/2026 academic year). Although the groups came from different schools, their equivalence was established through matched prior science report card scores and pretest comparison, and pretest scores were statistically controlled as a covariate in the ANCOVA. Critical thinking was measured using 8 expert-validated HOTS essay items, and data were analyzed using ANCOVA at a 5% significance level. NHT had a significant effect on critical thinking skills ($F=9.598$; $p=0.003$), with a higher mean posttest score in the NHT group (71.07) than in the control group (67.73). The findings suggest that NHT provides opportunities for students to explain ideas, discuss solutions, and assume individual accountability within groups, which may support the development of critical thinking skills.

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INTRODUCTION

Critical thinking is one of the 21st-century competencies that has become a major concern in science education in Indonesia, given that it and problem-solving are consistently among the most in-demand skills in today's workplace (Rios et al., 2020). Indonesian students' science literacy score on PISA 2022 stood at 383, down 13 points from 396 on PISA 2018; most 15-year-old students are still unable to model and evaluate complex problems scientifically (OECD, 2023). This data indicates that Indonesian students' reasoning and critical thinking abilities in the context of science still require serious attention, including at the junior secondary school level.

Critical thinking is defined as a reasoned decision-making process based on consideration of available evidence, encompassing the abilities of interpretation, analysis, evaluation, inference, explanation, and self-regulation in assessing an argument (Facione, 1990). Assessing this ability requires instruments specifically designed to capture students' reasoning processes rather than mere rote recall of concepts (Ennis, 1993). Critical thinking is important to develop from the junior secondary level onward, because students who possess this ability more easily understand concepts and are more sensitive to the problems they encounter during learning, including in Biology instruction, which is rich in scientific processes and contextual problem-solving. Critical thinking is the higher-order thinking skill most emphasized in biology education, as it prepares students to effectively address complex real-world problems, enhances their receptiveness to concepts, and heightens their sensitivity to learning challenges (Safitri et al., 2025).

One effort to develop critical thinking skills is to apply a scientific approach to learning. The Scientific Approach is a scientific learning process comprising the steps of observing, questioning, experimenting, reasoning, and communicating (Sari et al., 2024), and is relevant to Biology instruction, which is based on experimentation and direct observation of natural phenomena (Leão & Nascimento, 2024) (Nguyễn et al., 2022). Several studies report that this approach can increase students' active participation in learning (Simbolon & Sinaga, 2023), strengthen conceptual understanding of science, and make learning more meaningful (Qolbi et al., 2025). The Scientific Approach also contributes to strengthening critical thinking, as students are trained to attend to problem details and draw evidence-based conclusions (Murniati, 2023) (Chusni et al., 2020). Experimental studies among secondary school students have shown that science-inquiry-based learning activities significantly improve critical thinking compared with conventional instruction (Duran & Dökme, 2016). The Scientific Approach has a systematic sequence of learning stages, making it directly implementable in instruction. On the other hand, various studies indicate that the Scientific Approach does not stand alone and is frequently combined with various learning models. In classroom practice, the boundary between an approach and a model is often flexible, such that what matters most is how the learning structure facilitates students' cognitive, affective, and psychomotor development.

The Scientific Approach is flexible and can be integrated with various learning models to better suit students' needs (Gunawan et al., 2023). One model with strong potential for integration with the Scientific Approach is Numbered Heads Together (NHT), a cooperative learning model that promotes individual responsibility within groups through a member-numbering mechanism. NHT has been shown to significantly improve students' critical thinking skills in Biology instruction (Kusumaningtias et al., 2013) and in other subjects such as Physics, with a high effect size (Wati & Fatimah, 2016). The integration of NHT with the Scientific Approach specifically has also been shown to improve students' science process skills (Halfa, 2019).

The advantage of the NHT model integrated with the Scientific Approach over the Scientific Approach alone lies in the individual accountability structure inherent in NHT. This cooperative structure is rooted in social interdependence theory, which holds that students' learning outcomes are intertwined with those of their group members, thereby fostering greater motivation and effort than individual learning (Johnson & Johnson, 2009). Structured cooperative learning is grounded in four basic principles, namely positive interdependence, individual accountability, equal participation, and simultaneous interaction (Kagan, 1992). In NHT, these principles are implemented by numbering students and randomly calling a number to represent the group. This mechanism compels every group member, not only the dominant students, to genuinely understand and explain the outcome of each scientific step the group has undertaken, something that tends not to occur in the Scientific Approach without this kind of cooperative structure. The uncertainty of which number will be called also encourages cognitive elaboration among students before presentation. This pattern of interaction is consistent with the social constructivist view, which holds that understanding develops optimally

through interaction within the zone of proximal development (Vygotsky, 1978). Cooperative learning effectively improves learning achievement through a combination of group motivation, social cohesion, and cognitive elaboration (Slavin, 2015).

Support for this mechanism is also found in large-scale international studies. A meta-analysis focusing specifically on Biology instruction found that collaborative learning had a very large effect on students' critical thinking skills, with an effect size reaching 4.23 (Ramdani & Susilo, 2022). Similar findings have also been reported in the context of technology-based collaborative learning, where a meta-analysis of 30 empirical studies found a significant effect of collaborative learning on students' critical thinking (Tedla & Chen, 2025), as well as a meta-analysis of collaborative problem-solving learning that likewise demonstrated similar effectiveness in enhancing critical thinking (Xu et al., 2023). Consistent with this, a recent systematic review and meta-analysis of inquiry-based learning in science education also reported a large effect on students' critical thinking skills (effect size: 1.27), although the magnitude varied by educational level and instructional strategy (Arifin et al., 2025). In direct experimental studies, the use of jigsaw-type cooperative learning has also been shown to significantly increase posttest critical-thinking scores compared with a control group (Silva et al., 2023). The consistency of these findings, both in Indonesia and at the international scale, reinforces the argument that cooperative learning structures such as NHT provide a genuine added value for the development of students' critical thinking compared with individual-based learning.

Nevertheless, prior studies on the integration of NHT and critical thinking have largely been conducted in Mathematics, Physics, and general Science subjects; research specifically examining the integration of NHT and the Scientific Approach in junior secondary Biology instruction, particularly on the topic of the Plant Reproductive System, which requires understanding of complex processes such as pollination and fertilization, remains limited, and this is equally true in regions such as Ternate City. Based on preliminary observation, Biology teachers in Ternate generally have not systematically assessed students' critical thinking skills. The cognitive aspects assessed thus far have been limited to remembering (C1) and understanding concepts (C2), such that students' higher-order thinking potential has neither been mapped nor systematically trained. Biology instruction using the NHT model, integrated with the Scientific Approach, is expected to enhance the critical thinking skills of junior secondary students in Ternate. This study aims to analyze the effect of applying the NHT learning model, integrated with the Scientific Approach, on students' critical thinking skills in the topic of the Plant Reproductive System.

METHODS

Research Design

This study is a Quasi-Experiment with a Pretest-Posttest Control Group Design, in which the independent variable (Biology instruction using the NHT model integrated with the Scientific Approach) was applied to determine its effect on the dependent variable (students' critical thinking skills). A quasi-experimental design was chosen because full randomization of student placement into classes was not practically feasible, as is typical in school-based educational research with pre-existing fixed class structures (Gopalan et al., 2020). The study was conducted over three months, from March to May 2026, during the even semester of the 2025/2026 academic year, covering instrument development and validation, pretest administration, instruction according to each group's treatment, and posttest administration.

Table 1.

Pretest-Posttest Control Group Experimental Design

Group	Pretest	Treatment	Posttest
Experimental	O1	NHT integrated with Scientific Approach	O2
Control	O3	Scientific Approach (without NHT)	O4

Population and Samples

The study was conducted at two schools: SMPN 7 Kota Ternate, Indonesia the location for the experimental group, and SMP Nasional Banau Kota Ternate, Indonesia the location for the control group. The study population comprised all ninth-grade students at both schools. The sample was determined using a purposive sampling technique, selecting one class at each school with equivalent prior ability based on prior-semester science report card scores. The selected class at SMPN 7 Kota Ternate, Indonesia was designated as the experimental group (NHT instruction integrated with the Scientific

Approach), while the selected class at SMP Nasional Banau Kota Ternate was designated as the control group (Scientific Approach instruction without NHT integration). The equivalence of the two groups was subsequently confirmed statistically through an independent-samples t-test on cross-school critical-thinking pretest scores.

Instrument

The research instruments consisted of a critical thinking test and a learning observation sheet. The critical thinking test consisted of 8 essay items in the HOTS (Higher Order Thinking Skills) category, used to measure students' critical thinking skills on the topic of the Plant Reproductive System. The items were developed at higher-order cognitive levels according to the revised Bloom's taxonomy, namely analyzing (C4), evaluating (C5), and creating (C6). The same instrument was used for both groups so that measurement results could be compared on an equal basis. The learning observation sheet was used to determine the implementation fidelity of the lesson syntax during instruction in each group. Other research instruments consisted of the syllabus, lesson plans, and student worksheets. Critical thinking scores were assessed using a rubric adapted from the Illinois Critical Thinking Essay Test (Finken & Ennis, 1993) on a 0-5 scale, covering the six aspects present in Table 2.

Table 2.

Critical Thinking Assessment Rubric (Adapted from the Illinois Critical Thinking Essay Test, Finken & Ennis, 1993)

Aspect	Criteria Assessed	Score Range
Focus	Clarity of the student's stated position/opinion on the problem posed	0-5
Supporting Reasons	Relevance and sufficiency of the reasons/evidence used to support the opinion	0-5
Reasoning	Quality of the logical connection between evidence, reasons, and the conclusion given	0-5
Organization	Coherence and clarity of the structure of the response (introduction, body, conclusion)	0-5
Conventions	Accuracy of grammar, spelling, and scientific terminology used	0-5
Integration	Overall coherence of the argument as a unified, well-integrated response	0-5

Note: each aspect is scored on a range from 0 (indicator not demonstrated at all) to 5 (indicator demonstrated very well and consistently). Students' total critical thinking score is the sum of the six aspects.

Instrument validity (the test items, the learning observation sheet, and the learning materials, i.e., the syllabus, lesson plans, and student worksheets) was assessed through content validation by three expert validators prior to field use. In addition to content validation, item validity was tested empirically using item-total correlations (Pearson's r), by correlating each item's score with the total score. The item-total correlation results are presented in the table below. Item validation was conducted through a pilot test with 23 tenth-grade students at the sample school. All items showed a significant correlation with the total score ($p < 0.05$), with r values ranging from 0.566 to 0.856. This means all eight items are considered valid and suitable for measuring students' critical thinking skills.

Table 3.

Validity Test Results for the Critical Thinking Test Items

Item	Correlation (r)	p	Remark
Item 1	0.774	< .001	Valid
Item 2	0.620	.002	Valid
Item 3	0.606	.002	Valid
Item 4	0.566	.005	Valid
Item 5	0.842	< .001	Valid
Item 6	0.856	< .001	Valid
Item 7	0.702	< .001	Valid
Item 8	0.642	< .001	Valid

In addition to the validity test, instrument suitability was also determined through a reliability test, that is, the extent to which the instrument produces consistent measurement results when used repeatedly on the same subjects. The reliability of the test instrument was assessed using Cronbach's alpha (coefficient alpha) and Guttman's Lambda-2 to evaluate the internal consistency of the items. The reliability test results are presented in the table below.

Table 4.

Reliability Test Results for the Critical Thinking Test Instrument

Coefficient	Estimate	Std. Error	95% CI Lower	95% CI Upper
Coefficient α (Cronbach's Alpha)	0.843	0.053	0.739	0.947
Guttman's λ_2	0.850	0.049	0.754	0.945

A Cronbach's Alpha value of 0.843 is considered high (an excellent reliability category, as it exceeds the 0.80 threshold), indicating that the critical thinking test instrument used in this study has good internal consistency and is suitable for use as a measurement tool. Nevertheless, Cronbach's Alpha values should be interpreted with caution, as a high value does not by itself guarantee that an instrument purely measures a single underlying construct; appropriate interpretation still requires consideration of the context and purpose for which the instrument was developed (Taber, 2018).

Procedure

Prior to the experiment, two types of learning materials were developed: (1) a syllabus and lesson plan for the NHT model integrated with the Scientific Approach for the experimental class, and (2) a syllabus and lesson plan for the Scientific Approach (without NHT) for the control class. The syntax combining the NHT model and the Scientific Approach in the experimental class was as follows:

1. Numbering. The teacher divided students into groups of 4-5 members, with each member assigned a number from 1 to 5.
2. Observing. Students observed, read, listened to, and watched a video presentation.
3. Questioning. The teacher posed questions to students through the student worksheet.
4. Experimenting. Groups determined the data needed to answer the questions posed, identified data sources (objects, documents, books, experiments), and collected data according to the worksheet guidance (collaborative thinking).
5. Associating. Groups analyzed the data, identified relationships/categories within the data, and drew conclusions from the analysis.
6. Communicating. The teacher called one number at random from each group to present the group's conceptual findings orally.

Data collection consisted of: (1) a pretest to determine students' critical thinking skills before the experiment, (2) a posttest to determine students' critical thinking skills after treatment, and (3) peer observation of the implementation fidelity of the lesson syntax.

Data Analysis Techniques

Experimental data were analyzed using descriptive statistics (frequency, mean, and percentage). Class equivalence was tested using an independent-samples t-test. Hypothesis testing used ANCOVA at a 5% significance level, assisted by JASP and SPSS software, preceded by prerequisite tests of normality (visually using a Q-Q Plot and numerically using the Kolmogorov-Smirnov test) and homogeneity of variance using Levene's Test.

RESULTS AND DISCUSSION

This study applied two instructional treatments: the Numbered Heads Together (NHT) model integrated with the Scientific Approach, and the Scientific Approach (without NHT). At the pretest stage, the mean critical-thinking score of students in the NHT-integrated Scientific Approach group was 35.33, with scores ranging from 26-54, while the Scientific Approach (without NHT) group was slightly higher at 36.93, with scores ranging from 24-54. This small difference indicates that the two treatment groups' prior abilities were equivalent. The descriptive data for the pretest and posttest critical-thinking scores on the Plant Reproductive System topic are presented in.

Table 5.

Descriptive Statistics of Students' Critical Thinking Scores

	Pretest NHT Scientific	Pretest Scientific	Posttest NHT Scientific	Posttest Scientific
Valid	30.00	30.00	30.00	30.00
Missing	0.00	0.00	0.00	0.00
Median	32.00	36.00	71.00	68.00
Mean	35.33	36.93	71.07	67.73
SD	9.546	9.032	9.766	10.17
Minimum	26.00	24.00	48.00	42.00
Maximum	54.00	54.00	90.00	84.00

The results show a marked increase in posttest scores after instruction was carried out. The group of students taught using the NHT model integrated with the Scientific Approach experienced an increase in mean posttest score to 71.07 (median 71.00), while the Scientific Approach (without NHT) group increased to 67.73 (median 68.00).

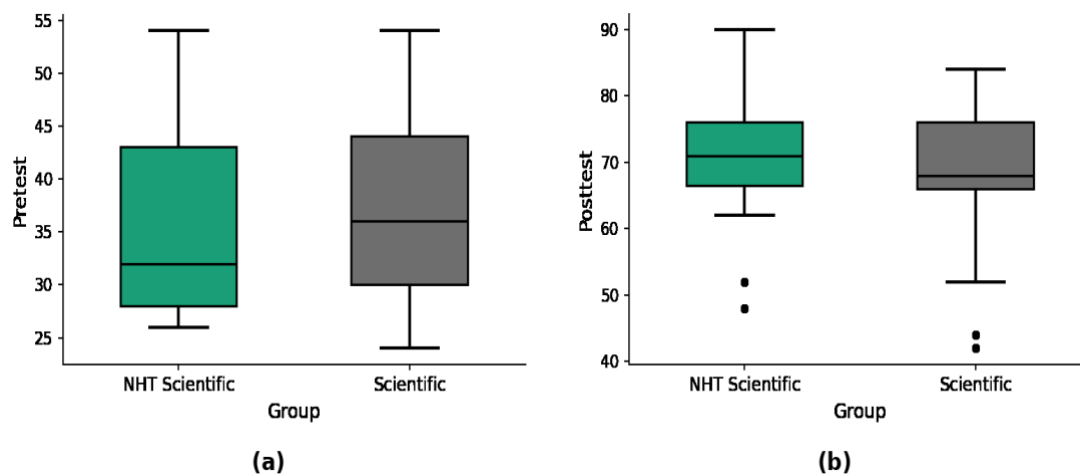


Figure 1. Boxplot of Students' Critical Thinking Scores by Group: (a) Pretest, and (b) Posttest.

The boxplot in Figure 1(a) shows a relatively equivalent distribution of pretest scores in both groups prior to treatment, while Figure 1(b) shows that the median posttest score of the NHT-integrated Scientific Approach group was higher than that of the Scientific Approach (without NHT) group, with the maximum score in the NHT-integrated Scientific Approach group reaching 90. This indicates that the collaborative NHT learning strategy, integrated with a scientific approach, is more effective at improving students' critical thinking skills in understanding the concept of plant reproduction. The learning process was not only more interactive but also placed greater emphasis on information gathering, data processing, and scientific inference, fostering higher-order thinking skills. As a complement, JASP also reported descriptive post-test statistics by group along with the Standard Error and Coefficient of Variation, as presented in Table 6.

Table 6.

Posttest Descriptives of Students' Critical Thinking Scores by Group

Group	n	Mean	SD	SE	Coefficient of Variation
NHT Scientific	30	71.07	9.766	1.783	0.137
Scientific (without NHT)	30	67.73	10.167	1.856	0.150

The lower Coefficient of Variation in the NHT-integrated Scientific Approach group (0.137) compared with the Scientific Approach (without NHT) group (0.150) indicates that posttest scores in the NHT-integrated Scientific Approach group were relatively more homogeneous/consistent among students than in the Scientific Approach (without NHT) group.

Normality testing of the data distribution was conducted to ensure that the observed score differences were not influenced by a skewed distribution and were purely the result of the instructional model's effectiveness. Normality was assessed visually using a Q-Q Plot (Quantile-Quantile Plot) on the pretest and posttest critical-thinking scores for each group, as shown in the JASP (Figures 2 and 3).

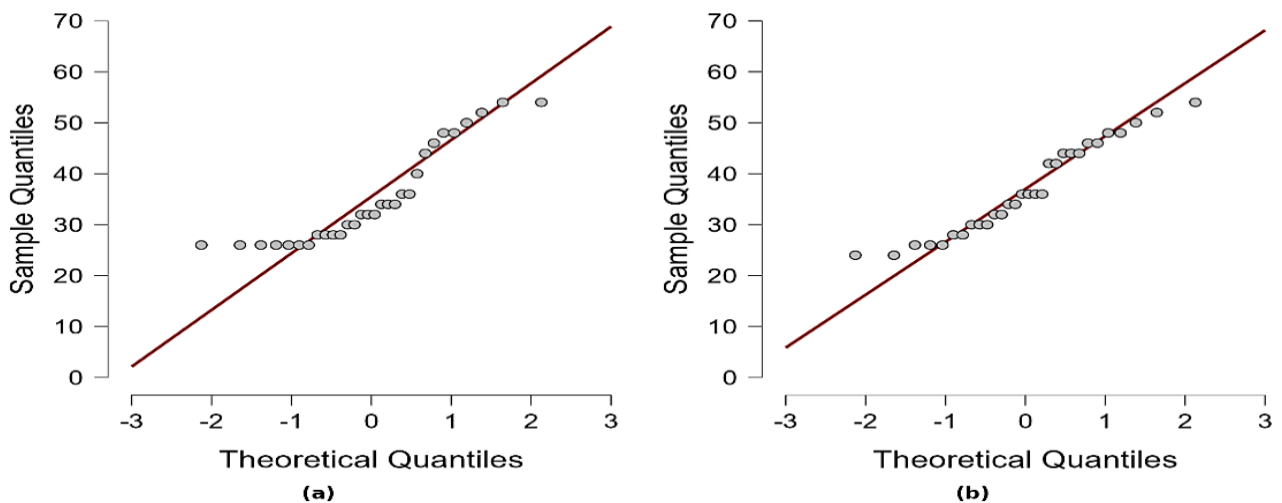


Figure 2. Q-Q Plot of Pretest Scores: (a) NHT-Integrated Scientific Approach Group, (b) Scientific Approach (without NHT) Group

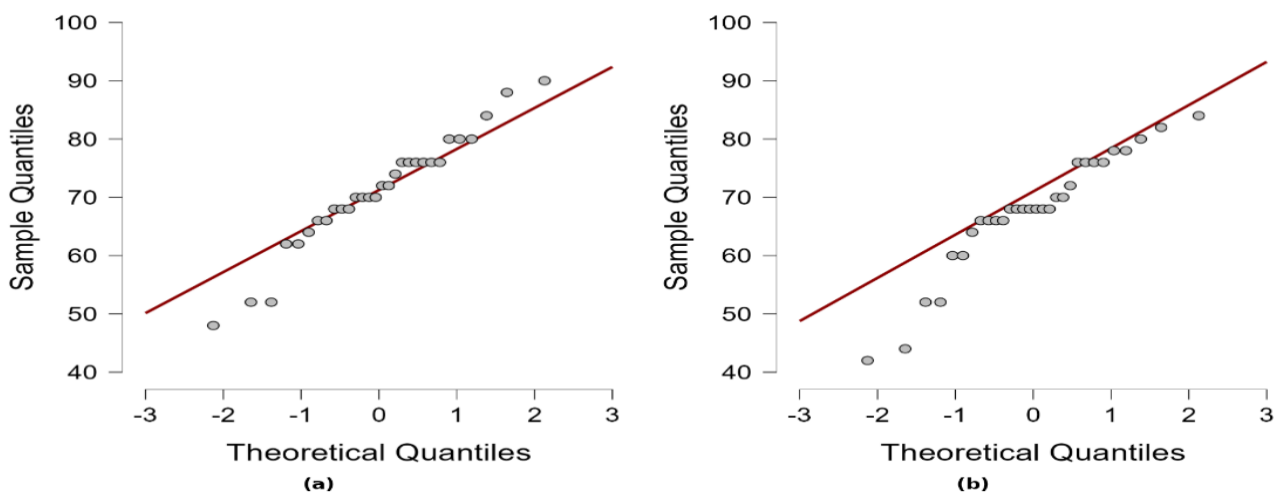


Figure 3. Q-Q Plot of Posttest Scores: (a) NHT-Integrated Scientific Approach Group, (b) Scientific Approach (without NHT) Group.

In [Figures 2 and 3](#), most data points follow the diagonal line, although some deviation appears at the lower tail. In the posttest, several low scores lie below the line in both groups, and this deviation is more pronounced in the Scientific Approach (without NHT) group (scores of 42 and 44), consistent with the outliers visible in [Figure 1\(b\)](#). Because visual inspection alone does not permit a firm conclusion, normality was also tested numerically using the Kolmogorov-Smirnov test, with the results presented in [Table 7](#).

Table 7.
Kolmogorov-Smirnov Normality Test Results for Students' Critical Thinking Scores

Data	Test	Statistic	p
Pretest	Kolmogorov-Smirnov	0.156	0.109
Posttest	Kolmogorov-Smirnov	0.150	0.137

The Kolmogorov-Smirnov test results show a p-value of 0.109 for the pretest data and 0.137 for the posttest data. Both values are greater than 0.05, so the critical-thinking score data are considered normally distributed. Another prerequisite that must be met before ANCOVA analysis is homogeneity of variance between groups, that is, whether the score variability in the NHT-integrated Scientific Approach group is equivalent to that in the Scientific Approach (without NHT) group. Homogeneity of variance was tested using Levene's Test, with the SPSS output results presented in [Table 8](#).

Table 8.

Homogeneity of Variance Test Results for Critical Thinking Scores

	Levene Statistic	df1	df2	Sig.
Critical Thinking Pretest	0.019	1	58	0.890
Critical Thinking Posttest	0.013	1	58	0.911

Levene's test results show a significance value of 0.890 for the pretest data and 0.911 for the posttest data, both far greater than 0.05. This means the variance of the critical-thinking score data in the two groups is homogeneous (equivalent), both before and after treatment. With both prerequisites met, namely normality and homogeneity, the data are suitable for further analysis using parametric statistics, including Analysis of Covariance (ANCOVA).

The analysis results show a significant effect of the instructional model on students' critical thinking skills, with $F=9.598$ and a significance value of 0.003. A significance value of $0.003 < 0.05$ means that, after controlling for the initial (pretest) score, the instructional model still made a significant contribution to improving students' critical thinking skills. The Analysis of Covariance (ANCOVA) results, as displayed in the JASP output, are presented in [Table 9](#).

Table 9.

ANCOVA Test Results for the Effect of the NHT Model Integrated with the Scientific Approach on Students' Critical Thinking Skills (Dependent Variable: Posttest)

Cases	Sum of Squares	df	Mean Square	F	p	ω^2
Group	332.4	1	332.36	9.598	0.003	0.049
Pretest	3,789.9	1	3,789.87	109.442	< .001	0.613
Residuals	1,973.9	57	34.63			

Note: Type III Sum of Squares; ω^2 = omega squared (an effect-size measure corrected for small-sample bias).

The omega-squared effect size indicates that the instructional model (Group) accounted for approximately 4.9% of the variance in posttest critical-thinking scores independently of the pretest ($\omega^2=0.049$), while the pretest score as a covariate accounted for a considerably larger share ($\omega^2=0.613$). This indicates that the use of the NHT model integrated with the Scientific Approach is genuinely superior in improving students' critical thinking skills compared with the Scientific Approach (without NHT) alone, particularly on complex topics such as the processes of fertilization, pollination, and plant fertilization, although the primary contribution to the final critical-thinking score still stems from students' prior ability.

The results show that instruction using the Numbered Heads Together (NHT) model combined with the Scientific Approach had a significant effect on improving students' critical thinking skills on the topic of the plant reproductive system, as shown by the ANCOVA results ($F=9.598$; $p=0.003$). The mean posttest score of the NHT-integrated Scientific Approach group (71.07) was higher than that of the Scientific Approach (without NHT) group (67.73), indicating that adding a group-work structure to scientific activities makes a genuine contribution to strengthening students' critical thinking skills. This finding is consistent with the conclusion that collaborative learning is generally more effective at training higher-order thinking skills than individual learning (Gillies, 2016).

The difference in achievement between the two groups can be explained through the ICAP framework (Interactive, Constructive, Active, Passive), which classifies students' cognitive engagement into four levels based on their impact on learning outcomes, from the lowest to the highest: passive, active, constructive, and interactive (Chi & Wylie, 2014). Instruction using the Scientific Approach (without NHT) tends to bring students to the constructive level, that is, building understanding individually through observation and independent reasoning. In contrast, the NHT structure drives students to the interactive level, because the numbering and random-calling mechanism requires students to explain ideas to one another and discuss to prepare a group answer. According to the ICAP framework, the interactive level of engagement consistently produces higher learning achievement than the constructive level (Menekse & Chi, 2019). This conclusion is further supported by a meta-analysis of 71 studies, which found that peer discussion consistently makes a positive contribution to the learning process compared with other learning methods, particularly when students are directed to reach a shared agreement during discussion (Tenenbaum et al., 2020).

The advantage of the NHT cooperative structure for complex material can also be understood through the perspective of collaborative cognitive load theory, which explains that human working

memory capacity is limited when processing information with interrelated elements (Kirschner et al., 2018). The topic of the Plant Reproductive System involves several interrelated processes, such as pollination, pollen tube formation, and fertilization, which can potentially overload students' working memory when studied individually. The group structure in NHT allows this cognitive load to be shared among group members, so that each student can process part of the complex information without having to bear the entire cognitive load alone (Kirschner et al., 2018).

The complexity of the plant reproduction topic is also a relevant factor to consider. International studies show that students at various educational levels tend to experience misconceptions in connecting the process of pollination with fertilization and seed formation, and have difficulty relating the plant life cycle as a whole (Lampert et al., 2019). The group discussion structure in NHT creates room for socio-cognitive conflict, that is, a condition in which differences in understanding among group members are negotiated and resolved through dialogue, which has the potential to be more effective at correcting such misconceptions than learning conducted individually (Doise & Mugny, 1984).

Quantitatively, the findings of this study are consistent with patterns reported in large-scale studies. Cooperative learning consistently has a positive effect on academic achievement, with the effect tending to be stronger in science and mathematics subjects than in social studies or language subjects (Kyndt et al., 2013), a pattern consistent with this study's context in Biology instruction. Likewise, peer tutoring in STEM subjects has been reported to have a very large effect size on students' academic achievement (Hidayat & Saad, 2025), reinforcing the argument that learning structures involving students explaining ideas to one another, as occurs in the NHT mechanism, provide genuine benefits compared with learning without such a collaborative structure.

The omega-squared effect size for the Group effect in this study is classified as moderate ($\omega^2=0.049$), but this does not necessarily mean the impact is not meaningful. Conventional effect-size benchmarks are not always relevant for judging the policy significance of an educational intervention, because low-cost, easy-to-implement classroom interventions can still be considered practically meaningful even when their statistical effect size is small to moderate (Kraft, 2020). Thus, the improvement in critical thinking skills among the NHT group in this study remains relevant for Biology teachers, as this model requires no additional cost or resources beyond restructuring group work, which is already commonly used in classrooms.

This finding is consistent with research reporting that the NHT model has a large effect on students' critical thinking skills compared with conventional instructional models (Febyani & Setiawan, 2022). Overall, these findings, both from local and international contexts, reinforce the argument that integrating the NHT cooperative structure into the Scientific Approach provides a genuine added benefit for developing students' critical thinking, particularly for complex Biology topics such as the plant reproductive system, compared with the application of the Scientific Approach (without NHT).

CONCLUSION

Based on the research results and discussion, it can be concluded that the Numbered Heads Together (NHT) learning model combined with the Scientific Approach significantly improved junior secondary students' critical thinking skills on the topic of the Plant Reproductive System ($F=9.598$; $p=0.003$), with a mean posttest score in the NHT-integrated Scientific Approach group (71.07) higher than in the Scientific Approach (without NHT) group (67.73).

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