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The effectiveness of integrated think-pair-share and make-a-match models on students' critical thinking in biology learning

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ABSTRACT

This study aims to determine the effectiveness of the think-pair-share (TPS) learning model combined with make-a-match to improve students' critical thinking skills. This research was motivated by the low critical thinking skills of students in Indonesia due to the application of learning models and strategies that are less appropriate and innovative, so that students are less free in expressing their thoughts, which causes students' critical thinking skills to be low. This study uses a quantitative approach with a type of quasi-experimental design research, using a non-equivalent pretest-posttest control group design involving two class samples given different treatments. The samples were taken based on a purposive sampling technique from two science classes at a senior high school in Cirebon. The data were gathered through pretest and posttest instruments. Furthermore, the data were then analysed using an independent sample t-test with SPSS software version 25. The results of this study indicate that there is a significant improvement in critical thinking skills with a significance result of $\alpha < 0.05$. This shows that the application of the think-pair-share model combined with make a match is effective for improving students' critical thinking skills.



INTRODUCTION

Education is an important thing for everyone in Indonesia. Education is inseparable from a person's life whether in a family, community, or nation (Şahin, 2023; Sunkad et al., 2025). In 2020, the United States Trade Representative (USTR) removed Indonesia from the category of developing countries and categorised it as a developed country (Isti & Sugini, 2022). But even so, the status of a developed country should certainly not change the country's principles and views on education (Effendi, 2024; Wirayuda et al., 2024). Developed countries also need potential human resources, and one of the things that can create quality and potential human resources is the education sector (Moshtari & Safarpour, 2023). Schools are one of the formal educational institutions that have a very important role in realising the objectives of national education, namely through the teaching and learning process (Pengfei & Meng, 2025).

If we look at UU No. 20 Tahun 2003, education in Indonesia aims to develop the potential of learners. (Supriyanto & Widjaja, 2025; Wulandari & Setiawan, 2023). Learners are social creatures who need the help of others to achieve success in education. (Song, 2024). The help may not only come from the teacher, but may also come from peers. Apart from being social creatures, students also act as individuals who have different abilities. (An & Zhang, 2024). Some students find it easy, and there are students who find it difficult to understand the subject matter. (Bahar & Polat, 2007). But in reality, in the learning process, there is still a lot of one-way interaction where the teacher actively dominates the lesson (Treve, 2024). Therefore, students are less flexible and are less given the opportunity to express their opinions and arguments in a problem (Ghafar, 2023). This can reduce student learning outcomes, especially in the aspect of students' critical thinking skills (Syamsul & Bahri, 2024; Wang, 2024).

Several studies have been conducted to find that there are still many students in Indonesia who have low critical thinking skills. This is as revealed by Adinda et al. (2021) in their research on the analysis of critical thinking skills in biology subjects, which shows the results that students' critical thinking skills are in the insufficient category based on Ennis' critical thinking skills indicators, especially on indicators of basic support, inference, advanced clarification, and strategy and tactics. In line with this, Nawawi et al. (2019), in a similar study, namely the analysis of critical thinking skills on cell material in several samples of senior high schools, have shown that critical thinking skills in biology subjects on biological material are in a very low category.

Meanwhile, critical thinking skills are a very important skill for students to have. Critical thinking skills are very important to be taught at school because they can achieve a deep understanding of the material, the ability to process information behind an event, decide and conclude so that students feel involved in their own knowledge (Masitoh et al., 2017). Learning that does not emphasise efforts to develop critical thinking skills puts students into rote learning, so learning becomes less meaningful, and students easily forget the material that has been taught before (Zeidler et al., 2005).

Therefore, a learning model design is needed to improve students' critical thinking skills. One of them is by implementing a learning model that can provide opportunities for students to be able to express opinions related to a phenomenon as widely as possible (Nurhuda et al., 2023). These models enhance scientific literacy by valuing student preconceptions and enabling iterative debates, as seen in discovery learning for opinion-writing tasks (Prasetyo et al., 2025). One of the learning models that can improve students' critical thinking skills is the think-pair-share model (TPS) (Azzahra et al., 2024).

Various previous studies have proven the effectiveness of the application of the think-pair-share model to improve students' critical thinking skills. Such as research conducted by Siswati et al. (2023) who applied the think pair share learning model to improve students' critical thinking skills in science subjects; Wicaksono et al. (2017), who applied the think pair share learning model to improve students' critical thinking skills in mathematics subjects; Boleng (2014), who applied the think pair share model and cooperative script to improve students' critical thinking skills in

biology subjects; and Ramadansur et al. (2025) who applied the think pair share model and the pattern of empowering thinking through questions to improve students' critical thinking skills in biology subjects. Based on the results of the study, it can be seen that this cooperative learning model of the think-pair-share type can significantly improve students' critical thinking skills (Pujianti et al., 2025).

The think-pair-share learning model can also be applied by combining it with other learning strategies, such as one of them by combining with the make a match learning strategy (Siwalette, 2025). The make a match learning strategy is one that organises the class by having students discuss in pairs (Nufitasari et al., 2024). In the implementation of the make a match learning model, the teacher prepares cards containing problems with solutions or answers (Rizal & Maharani, 2025). Students will then look for their partner based on the match of the card obtained, so they will be directly involved in the learning process (Utami et al., 2021). Frank Lyman in Rusman (2016) has stated that Make a match is a learning model that provides opportunities to think independently, find a suitable partner, and then discuss with other pairs in finding the same concept.

Philosophically, both the Think Pair Share and Make a Match models are grounded in Vygotsky's socio-constructivist theory of cooperative learning, which posits that learning is fundamentally a social process and that higher-order thinking develops through interaction within a learner's zone of proximal development (Vygotsky, 1978). Through structured peer interaction and scaffolding from a more capable partner, students are guided to construct an understanding that exceeds what they could achieve individually. This socio-constructivist foundation is reflected in the characteristics of each model. Think Pair Share emphasizes individual reflection at the Think stage prior to the social negotiation of meaning at the Pair and Share stages, thereby giving every student the cognitive space to formulate an initial position before it is tested and refined through dialogue. Make a Match, in contrast, embeds this social negotiation within a game-like matching activity, in which students actively search for a partner holding a complementary card, creating an immediate and low-stakes opportunity for peer scaffolding. Both models therefore share the same cooperative-learning philosophy rooted in Vygotsky's theory, but differ in the mechanism through which social interaction is structured, which is the basis for their integration in this study.

Based on research conducted by Daud & Maulina (2021) revealed that the use of ordinary cooperative methods that rely on discussion strategies between students alone will cause learning activities that occur to be dominated by only a few students. So that students who are less active in learning will tend to have low mastery of the materials. So to overcome this, think pair share models can be combined with the make a match strategy which will provide opportunities for all students to be more active in learning by completing their tasks in smaller groups consisting of only two people (Siwalette, 2025; Sitopu et al., 2022).

With the combination of these two learning models, learning will be more structured. In the think pair share learning model there is a stage where students are grouped at the pairing stage; the pairing technique in this pairing stage can use the cards used in the make-a-match learning model (Arminiati et al., 2024). This hybrid fosters critical thinking and equity, as students actively seek matches before discussing, making learning more dynamic. Studies note higher engagement in smaller duos compared to larger groups (Guenther & Abbott, 2024). Then, each pair will discuss concepts related to the topic on their card (Arminiati et al., 2024).

Based on this, to determine the effectiveness of the combination of think pair share and make a match cooperative learning models to improve students' critical thinking skills, researchers are interested in examining the effectiveness of the application of the think pair share model combined with make a match in biology learning in class XI senior high school. This study is intended to determine the effectiveness of combining the two learning models to improve students' critical thinking skills.

METHODS

Research Design

This study was designed using a non-equivalent pretest-posttest control group design, where two class groups will be selected using a purposive sampling technique. Then the two class groups that have been selected will be given a pretest to find out the initial situation, then after being given the treatment, the two class groups will be given a posttest to find out the situation after being given the treatment.

Population and Samples

This study involved all 11th-grade Science students at a senior high school in Cirebon as the research population. Two classes, XI MIPA 1 and XI MIPA 2, were selected as the research sample using a purposive sampling technique.

Instrument

This study employed three instruments to collect data in order to determine the effectiveness of implementing the Think Pair Share learning model combined with Make a Match. The observation sheet was used to assess students' learning activities during the instructional process. Throughout the learning activities, an observer monitored students' behaviors by referring to the observation sheet and its corresponding assessment guidelines. The data obtained consisted of students' learning activities, which encompassed indicators of critical thinking skills.

The instrument used aims to measure acquisition learning outcomes containing critical thinking skills in biology subjects in the material of cells. The instrument in question is a test of learning outcomes in the form of test questions containing critical thinking skills. The test developed to measure the learning gain is a multiple-choice test. Critical thinking skills test questions to determine students' critical thinking skills, as measured by critical thinking skills indicators by Robert Ennis, including: (1) Elementary clarification; (2) Basic support; (3) inference; (4) Advanced clarification and; (5) Strategy and tactics.

A questionnaire was used to identify students' responses to the implementation of the Think Pair Share learning model combined with Make a Match in the experimental class. The questionnaire was administered to the students, and the data obtained consisted of their responses to the applied learning model. These data were then used as a basis for determining whether the TPS learning model combined with Make a Match is appropriate for implementation.

Procedure

The research procedures carried out on the research subjects include giving a pretest, giving treatment in the form of applying the learning model and then conducting a post-test after all meetings are held. The experimental procedure was arranged as shown in Table 1 below.

Table 1

Non-equivalent pretest-posttest control group design.

Pre-test	Treatment	Post-test
O1	X	O2
O3	C	O4

Information:

O1 & O3 = Observation of pretest result

O2 & O4 = Observation of posttest result

X = Application of think pair share model combined with make a match

C = Application of think pair share model

The novelty of this study lies in the explicit integration of the Think Pair Share and Make a Match stages into a single instructional sequence, rather than applying the two models separately or sequentially. The integrated design was structured into four stages: (1) Think stage, in which each student individually analyzed a contextual problem on the LKPD and formulated a preliminary answer; (2) Pair stage, in which the pairing mechanism of Make a Match was employed instead of teacher-assigned pairing—students searched for a partner holding a matching problem-solution card, so that the process of finding a pair itself became part of the cognitive task; (3) Match-Discuss stage, in which the newly paired students compared and negotiated their individual answers to reach a joint response, integrating the discussion element of Think Pair Share with the matching mechanism of Make a Match; and (4) Share stage, in which selected pairs presented their joint answer to the class for clarification and feedback. This sequence differs from the standard Make a Match procedure, which typically ends once a pair is formed, by embedding a structured discussion phase adapted from Think Pair Share into the matching activity itself.

The two class samples received different treatments across the two meetings. The control class was given the standard Think Pair Share model, in which students worked individually at the Think stage, were paired by the teacher rather than through a card-matching activity, and then shared their paired conclusions in a whole-class discussion. The experimental class received the integrated Think Pair Share and Make a Match treatment described above, in which pairing was achieved through the Make a Match card mechanism. Both classes worked on the same contextual problems related to cell material and were taught by the same teacher within the same allocated time, so that the pairing mechanism and the presence or absence of the card-matching activity constituted the primary difference between the two treatments.

During the treatment phase, students in the experimental class were facilitated with a specifically designed Student Worksheet (*Lembar Kerja Peserta Didik/LKPD*). This worksheet was structurally integrated with the Think Pair Share and Make a Match phases. It contained contextual problems regarding cell material designed to stimulate students' critical thinking indicators, such as elementary clarification, inference, and basic support. A snippet of the LKPD used during the instructional process is presented in Figure 1.

Figure 1

A snippet of the Student Worksheet (LKPD) on cell material designed to stimulate critical thinking skills.



Data Analysis Techniques

Data analysis technique used to determine differences in students learning activities between the class implementing the Think Pair Share learning model and the class implementing the Think Pair Share model combined with Make a Match involved calculating the average percentage of students learning activities during the instructional process. These activities were directly observed by an observer using a student learning activity observation sheet and its corresponding assessment guidelines.

The data analysis was conducted in two stages: prerequisite testing and hypothesis testing. As prerequisites for the statistical hypothesis analysis, normality and homogeneity tests were first carried out. The hypothesis testing was then performed using the N-Gain test together with the independent samples t-test, all processed through SPSS software version 25.

The N-Gain value was calculated to determine whether there was an increase in learning outcomes reflecting critical thinking skills after the learning was applied. The normalized gain score was obtained by dividing the difference between the posttest and pretest scores by the difference between the maximum score and the pretest score, and then multiplying the result by 100.

The independent samples t-test was used to address the problem formulation, which examines the effectiveness of applying the Think Pair Share model combined with Make a Match. To determine this effectiveness, the test was carried out on the N-Gain scores of both the experimental and control classes, so as to identify the difference in the improvement of learning outcomes involving critical thinking skills, through SPSS software version 25.

In addition to measuring effectiveness, an analysis was conducted to examine students' responses to the implementation of the Think Pair Share model combined with Make a Match. This was done by calculating the average percentage of the questionnaire results completed by the students, which were then interpreted and categorized into several criteria.

RESULTS AND DISCUSSION

Observations of students' learning activities were conducted by an observer in both classes during the instructional process over two meetings. The experimental class implemented the Think Pair Share learning model combined with Make a Match, while the control class implemented the Think Pair Share learning model. The calculated average percentages of students' learning activities are presented in Figure 2.

Figure 2

Average student learning activity chart.

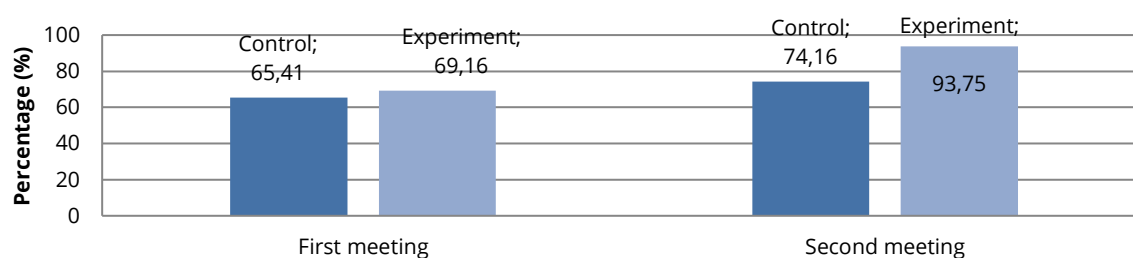


Figure 2 shows that during the first meeting, both classes achieved scores within the range of 61–80%, which falls under the “good” criterion. A difference of 3.75% in learning activity levels was observed, with the experimental class demonstrating higher student engagement. During the second meeting, learning activities increased in both classes. The most substantial improvement occurred in the experimental class, with an increase of 24.59%, reaching the range of 81–100%, which corresponds to the “very good” criterion. These findings indicate that the implementation of the Think Pair Share learning model combined with Make a Match effectively enhances students' learning activities.

Based on the result of the N-gain calculation of learning outcomes with critical thinking skills, it can be seen that in both experimental and control class, there is an increase in learning outcomes with critical thinking skills which both get the N-gain value category “moderate”. This indicates that the two learning models applied to experimental and control classes can both improve students' critical thinking skills. The summary of N-gain score and independent sample t-test results can be seen in table 2.

Table 2*Summary of N-gain scores and independent sample t-test results.*

Class	Pretest (M)	Posttest (M)	t	df	Sig.(2-tailed)
Experiment	49.20	82.66	3.865	58	0.000
Control	46.44	66.77			

As shown in Table 2, the experimental class that applied the Think Pair Share learning model combined with Make a Match achieved the greatest improvement in learning outcomes related to critical thinking skills. To determine whether this improvement differed significantly between the two classes, a statistical hypothesis test was conducted. The independent samples t-test results in Table 2 reveal a significant difference in critical thinking skill improvement between the experimental and control classes. This can be seen based on the results of the independent sample t-test in Table 2, where the Sig. value of Levene's Test for Equality of Variances is 0.956, which is greater than the specified significance value of 0.05. This means that the variance of the control and experimental class N-Gain data is homogeneous, so the interpretation of the independent sample t-test results is guided by the value of the Equal variances assumed table. In the table, it is known to have a Sig. (2-tailed) of 0.000 which is smaller than the specified significance value of 0.05, so as the basis for decision making in this test, it can be concluded that there is a significant difference in the improvement of critical thinking skills in both classes. Therefore, it can be concluded that the application of the think pair share learning model combined with make a match is effectively applied to learning cell material in biology subject to improve students' critical thinking skills.

The questionnaire was administered to students in the experimental class after the learning process to obtain data on their responses to the implementation of the Think Pair Share learning model combined with Make a Match. The questionnaire consisted of several statements designed to measure students' perceptions, engagement, and acceptance of the applied learning model. Students' responses were collected and analyzed by calculating the average percentage of each item, which was then interpreted according to predetermined criteria. The results of the questionnaire analysis are presented in Figure 3.

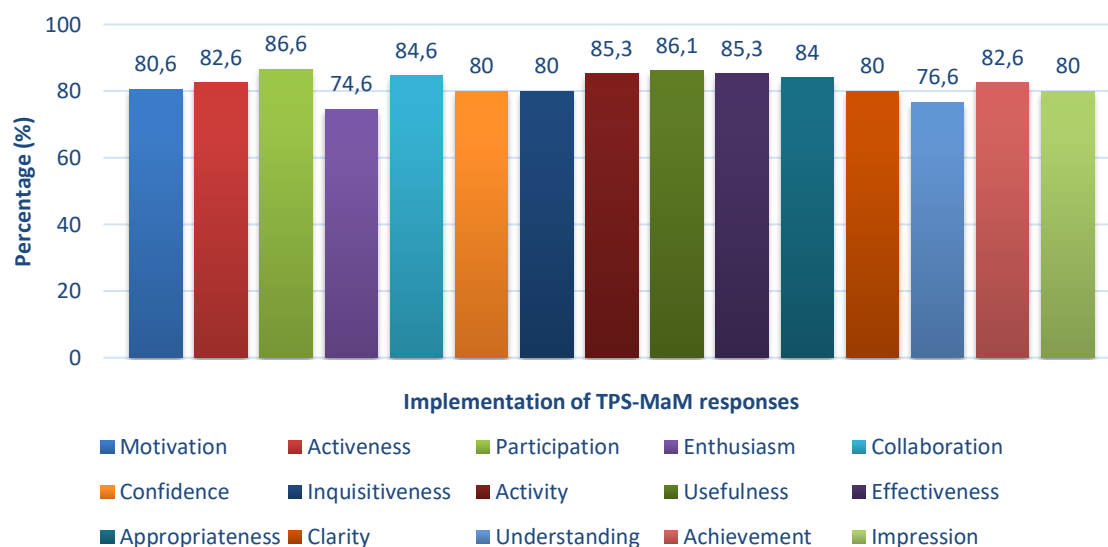
Figure 3*Summary of questionnaire results*

Figure 3 presents the average questionnaire scores of students' responses to the implementation of the Think Pair Share learning model combined with Make a Match. In the bar chart, the orange bars represent questionnaire indicators classified under the implementation dimension, while the blue bars represent indicators belonging to the evaluation dimension. The results show that six questionnaire indicators obtained average percentage scores within the range of 61–80%, which can be interpreted as a “good” response from the students. Meanwhile, nine questionnaire indicators achieved average percentage scores within the range of 81–100%, indicating a “very good” student response. These findings suggest that the implementation of the Think Pair Share learning model combined with Make a Match received positive responses from students in both implementation and evaluation dimensions. Therefore, this learning model can be effectively applied in classroom settings to support the improvement of students' thinking skills.

The results of this study are in accordance with previous research that examines the effectiveness of think pair share and make a match learning model. This is in line with the results of research conducted by Siswati et al. (2023) who applied the think pair share model to improve students' critical thinking skills which found that the think pair share learning model can improve students' critical thinking skills in the science subject (*IPA*). Likewise, research conducted by Boleng (2014), Idhar et al. (2019), and Wicaksono et al. (2017), has also proven that the think pair share learning model can improve critical thinking skills. Furthermore, various studies have also proven that the make a match learning model can also improve students' critical thinking skills. Such as research conducted by Marzuki (2024) related to their research which examines the application of the make a match learning model to improve the critical thinking skills of elementary school students, and research conducted by Novita et al. (2021) which examines the effect of the make a match model on the critical thinking skills of high school students. The results of the study state that the make a match learning model can improve students' critical thinking skills.

Because both the think pair share model and the make a match model can both improve critical thinking skills, both can be integrated in a lesson. Think pair share learning model is one type of cooperative learning. Safitri & Nasrudin (2022), revealed that cooperative learning will produce optimal impact when combined with other learning models. Daud & Maulina (2021) on the journal article revealed that the use of ordinary cooperative methods that rely on discussion strategies between students alone, will cause the group learning activities to be dominated by only a few students, and the others just follow and rely on other friends. So that students who are less active in learning will tend to have low mastery of the material. From the results of interview conducted by Daud & Maulina (2021), it is known that students who are less active in cooperative learning have low motivation and interest in learning. The low motivation to learn is one of the factors that cause students' learning outcomes and critical thinking skills to be low. So, to overcome this, cooperative learning type think pair share can be combined with make a match strategy which will allow students to be more active in learning by completing their tasks in groups of only two people.

By using small groups of 2, all students in the class will participate in the learning. So that students' understanding of learning materials can also increase, including critical thinking skills. As can be concluded in this study that the application of the think pair share learning model combined with make a match can significantly improve critical thinking skills.

Think pair share learning model is one of type of cooperative learning. The success of this integrated model in enhancing critical thinking can be attributed to the fulfilment of cooperative learning principles. Johnson & Johnson (2019) emphasized five vital elements for effective group learning: positive interdependence, individual accountability, promotive interaction, social skills, and group processing. In this study, the *Make a Match* phase stimulated face-to-face interaction and interpersonal skills as students actively searched for their pairs. Meanwhile, the *Think Pair Share* phase fostered personal responsibility and positive interdependence, as each student had to independently understand the concept before discussing and presenting it with their partner.

This comprehensive group processing ultimately led to a deeper mastery of the material and sharpened their critical thinking.

Beyond the numerical gains, the integration of Think Pair Share and Make a Match also carries distinct strengths and limitations that are worth discussing. The main strength of Think Pair Share lies in its individual Think stage, which gives every student, including those who are normally passive, a protected opportunity to formulate their own understanding before it is subject to social comparison, thereby reducing the tendency of more vocal students to dominate the discussion (Guenther & Abbott, 2024). However, when applied on its own, Think Pair Share depends heavily on teacher-assigned pairing, which can result in a passive partner simply agreeing with a more dominant one rather than genuinely negotiating meaning. Make a Match, on the other hand, has the advantage of turning the pairing process itself into an active, game-like cognitive task, which increases student enthusiasm and engagement (Marzuki, 2024; Novita et al., 2021). Its main limitation is that the matching activity can become mechanical, with students focusing on quickly finding a card rather than on understanding the underlying concept, and it can also be time-consuming when the number of cards is large. By combining the two models, the weaknesses of each can be minimized: the Think stage of Think Pair Share ensures that students already hold a preliminary concept before searching for a match, so that the Make a Match activity is less likely to become a mechanical guessing exercise, while the card-matching mechanism of Make a Match replaces teacher-assigned pairing and keeps every student actively involved. This complementary relationship, rather than the numerical improvement alone, explains why the integrated model outperformed the single Think Pair Share model in this study.

CONCLUSION

Based on the results of the study on the effectiveness of the Think-Pair-Share learning model combined with Make a Match in biology learning, it can be concluded that this combined learning model is effective in improving students' critical thinking skills. This is evidenced by the more significant increase in students' learning activities in the experimental class compared to the control class. Furthermore, about learning outcomes related to critical thinking skills, the experimental class demonstrated a greater improvement, as indicated by the N-gain analysis and statistical testing. In addition, the Think-Pair-Share learning model combined with Make a Match received positive responses from students. Therefore, this learning model can be considered for classroom implementation, particularly to support the enhancement of students' critical thinking skills. This is due to the combination of two cooperative learning models, namely Think-Pair-Share and make a match, so that the combination makes learning activities more interesting and structured. the combination of these two learning models will make all students actively involved in learning activities because only two paired groups are applied. And the paired card media will make learning more interesting and fun.

This study is limited to two classes of eleventh-grade students in a single school, so the findings on the effectiveness of the integrated Think Pair Share and Make a Match model should be generalized with caution. Future research is recommended to examine the application of this integrated model across different schools, grade levels, and subject matter, as well as to explore its long-term effect on students' critical thinking skills.

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