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Improving Collaboration Skills, Critical Thinking, and Science Learning Achievement in Grade VII through Discovery Learning with TarL Approach

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Abstract: Collaboration skills, critical thinking skills, and learning achievement are important for every student to have. However, the results of the researcher's observation in class VII D SMP N 4 Depok showed that collaboration skills, critical thinking, and science learning achievement were still low. Therefore, this study aims to analyze the improvement of collaboration skills, critical thinking skills, and learning achievement of students in class VII D SMP N 4 Depok after learning the Discovery Learning model with TarL approach on Earth and Solar System material. This research is a classroom action research (PTK) model of Kemmis & Mc Taggart with two cycles consisting of four stages, namely planning, action, observation, and reflection in each cycle. The subjects in this study were students of class VII D SMP N 4 Depok. Data collection techniques used observation, questionnaires, tests, and documentation. Data analysis of questionnaire and test results used descriptive statistics and n-gain test. The results obtained showed that there was an increase in cycle 1 to cycle 2 in the medium category, namely 1) collaboration skills with N Gain 0.413; 2) critical thinking skills with N Gain 0.413. Critical thinking ability with N Gain 0.474; 3) Learning achievement with N Gain 0.532. Thus, the application of Discovery Learning with TarL Approach is effective to improve collaboration skills, critical thinking skills, and learning achievement.

Keywords: Discovery Learning, TaRL Approach, Collaboration Skills, Critical Thinking Skills, Science Learning Achievement.

Introduction

Education plays an important role in a person's growth and development because education encourages individuals to learn and acquire knowledge in everyday life. Recognizing the important role of education, the Ministry of Education and Culture (MoEC) has implemented the Merdeka Curriculum to improve the quality of education. Every individual has different abilities and levels of understanding. Likewise, some students have substantial knowledge or still understand basic concepts (Pettersson, 2021). This different level of knowledge among students is a challenge in education, often resulting in gaps in learning achievement and critical thinking skills (Nor & Sihes, 2021; Tang et al., 2020).

Critical thinking is an essential skill in education, but it is still difficult for many students to develop, especially those who face challenges in understanding basic concepts. Haber, (2020) observed that while some students thrived in advanced topics, others had difficulties with foundational concepts, which ultimately affected their long-term development. Critical thinking was identified as a high-level skill that could improve students' analytical abilities, having a positive impact on the learning process. By emphasizing

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the importance of critical thinking, educators aimed to enhance students' overall learning experiences and support their academic growth (Muaffiani et al., 2022; Susilawati et al., 2020). This skill not only improves the quality of understanding, but also strengthens relevance in solving more complex problems. With critical thinking, students can analyze, evaluate, and develop their thinking more effectively, which is essential in facing academic challenges and everyday life (Sarwanto et al., 2021; Shanta & Wells, 2022).

Based on the results of observations of researchers in class VII D SMP N 4 Depok, it shows that collaboration skills, critical thinking, and science learning achievement are still low. This can be seen from several indicators, namely 1) They tend to work on tasks individually, without paying attention to other group members when working on group Learner Worksheets (LKPD); 2) Learners do not interact much with each other in completing group assignments. They tend to be silent and work alone; 3) Learners are not responsible for group tasks. They tend to only rely on other group members to complete the task; 4) Learners do not have an effective group process in completing the task.

This condition indicates that learners need to enhance their collaborative skills. By improving these skills, we encourage students to engage more actively in their learning, which will support the development of their critical thinking and overall academic achievements. Collaborative learning offers a solution by creating an environment that fosters group interaction and accountability, allowing students to learn from one another.

Learners' collaborative skills can be seen from the behavior of positive interdependence, face-to-face interaction, individual responsibility, interpersonal relationships, and group processes (Shimizu et al., 2022). Collaborative learning occurs when students engage in group activities to enhance the collective learning experience (Chang & Benson, 2020; Chopra & Kauts, 2023). Collaboration in the classroom facilitates student interaction, idea sharing, and mutual learning, fostering essential skills such as problem-solving, communication, and teamwork (Afikah et al., 2022; Putri et al., 2023; Sotto Jr, 2021).

Other research states that through collaborative skills, students are able to develop critical thinking skills (Saputra et al., 2019; Warsah et al., 2021). The results of research conducted by Barus et al., (2018) showed that the ability to think critically on the self-concept of students obtained a significant direct effect on learning outcomes. In addition, a positive relationship with moderate and significant criteria is obtained between self-concept and critical thinking skills of students together with science learning outcomes (Barus et al., 2018; Fadillah et al., 2023).

In class VII D, students' critical thinking skills are still low. This can be seen from their weak ability to interpret arguments into student worksheets (LKPD), explain answers rationally and logically, and make conclusions about the material that has been presented by the teacher. Therefore, it is necessary to improve students' critical thinking skills, collaboration skills, and learning achievement through the right learning approaches and models. Discovery Learning is a cognitive learning model that requires teachers to be more creative in creating situations that can make students learn to actively find their own knowledge (Rosnidar et al., 2021; Zajda & Zajda, 2021). So that the teacher should be able to create interesting learning so that students do not get bored quickly with a lesson (Iskandar et al., 2024). TaRL's approach makes students active and student-centred learning, increasing their cognition (Aryanti, 2024). However, the TaRL approach that has been implemented has the disadvantage that it requires more than one teacher for learning to be effective, or learning can be carried out in collaborative team teaching (Arfani et al., 2023). The discovery learning model with the TaRL approach is considered to be able to improve collaborative skills, critical thinking, and learning achievement because in its implementation, students according to their ability level working on LKPDs that have been adapted to the syntax of discovery learning (Kusumastuti et al., 2020; Makhmudah et al., 2021; Rahmadhani & Ardi, 2024; Rahman, 2023; Sitompul et al., 2023).

The increase in learning achievement results is in line with research conducted by Utami et al., (2024) at SMP N 2 Makassar which states that the discovery learning model with the TaRL approach can improve student learning outcomes and students become more active. In addition, the discovery learning model with the TaRL approach can improve critical thinking skills in line with research conducted by Hasanah et al., (2024) at SMP N 18 Makassar which states that the discovery learning model with the TaRL approach starting from cycle 1, cycle 2, and cycle 3 shows an increase in students' higher-level thinking skills. The completeness score will group of high-level thinking skills in cycles 1, 2, and 3 is 34%, 52% and 79% respectively.

Based on the results of the observations that have been made, previous research generally emphasizes improving high-level thinking skills in the context of classroom learning. In contrast, this research focuses more on applying the model to improve students' collaboration and critical thinking skills, which aligns with the approach recommended in the Merdeka

Curriculum, especially in developing 21st-century skills through project-based and collaborative learning. Therefore, this researcher tries to implement the discovery learning model with the TaRL approach to improve students' collaboration skills, critical thinking, and learning achievement in class VII D SMP N 4 Depok, Yogyakarta.

Method

This type of research is Classroom Action Research (CAR) with the Kemmis & Mc Taggart model which consists of four stages, namely planning, action, observation, and reflection as shown in Figure 1. The subjects used were students of class VII D SMP Negeri 4 Depok. This research was conducted for 2 cycles in the 2024/2025 school year. Data collection techniques were carried out using observation, questionnaires, tests, and documentation. Collaboration skills data were obtained using a questionnaire (Pre-Post) in each cycle compiled in the form of a Google Form with a Likert scale. This questionnaire is designed to measure various aspects of students' collaboration skills, such as actively contributing, cooperating productively, showing flexibility and compromise, managing projects well, showing respect, and showing responsibility (Greenstein, 2012). The collaboration skills questionnaire consisted of 25 statements with 13 positive statements and 12 negative statements for cycle 1, while for cycle 2, it consisted of 20 statements with 13 positive statements and 7 negative statements. To assess students' critical thinking abilities, this study employed an examination test that followed a pretest and posttest format in each cycle. The test is designed to evaluate students' skills in analyzing and solving problems across various aspects, including (elementary clarification basic support, inference, and advanced clarification along with strategies and tactics) (Ennis, 1987). The critical thinking ability test consisted of essay questions, with 5 questions for each cycle. Additionally, a multiple-choice test was utilized to measure learning achievement, which was also conducted in a pretest and posttest format, consisting of 15 questions in cycle 1 and 10 questions in cycle 2, specifically for the Earth and Solar System material, covering the subtopics of the Solar System, Earth and its Satellites, and Getting to Know the Sun More Closely. Meanwhile, the learning tools used were the Earth and Solar System Science Teaching Module and Worksheets, which have been carried out content validity and construct validity.

Data analysis techniques were carried out using qualitative and quantitative methods. Data analysis of students' collaboration skills was carried out descriptively quantitatively in accordance with the scoring guidelines for questionnaires with a Likert scale of 1-4. Data analysis of students' collaboration skills, critical thinking and learning achievement of students was carried out with descriptive statistics which were reviewed from the acquisition of scores obtained from the scoring guidelines as shown in formula 1.

$$Score = \frac{\Sigma Scores\ Bbtained}{\Sigma Maximum\ Score} \times 100$$

……. (1)

Then to evaluate the improvement that occurs in collaboration skills, critical thinking skills, and student learning achievement after following the learning process, the n-Gain test is carried out as shown in Formula 2. The n-Gain value that has been obtained is then categorized as Table 1.

$$N - Gain = \frac{(Posttest - Pretest)}{(Maximum\ Score - Pretes)} \times 100$$

…….(2)

Table 1. The N-Gain Score Categories

Average N-Gain	Category
0,70 < N-Gain ≤ 1,00	High
0,30 < N-Gain ≤ 0,70	Medium
N-Gain ≤ 0,30	Low

(Hake, 1999)

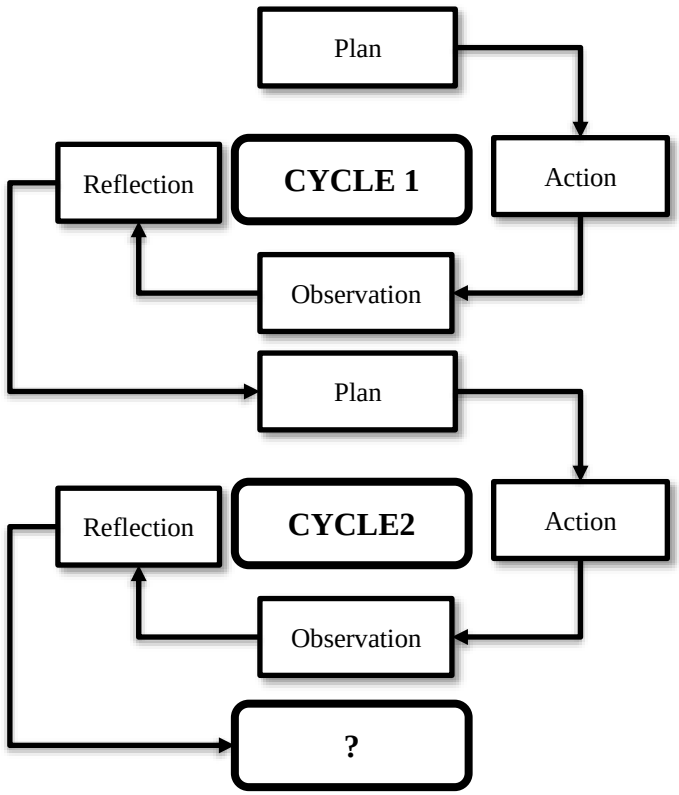

Figure 1. Kemmis and Mc Taggart Classroom Action Research Model Design
(Arikunto, 2015)

Result and Discussion

This research was conducted in the even semester on earth and solar system material in the 2023/2024 academic year. The activities carried out in this study were to implement the discovery learning model with the TaRL approach to improve collaboration skills, learning achievement, and critical thinking. The first thing to do is to conduct a cognitive diagnostic assessment to group students based on their initial abilities. Next, develop evaluation instruments. There are 3 evaluation instruments: questionnaire to measure learners' collaborative skills, pretest posttest to measure learning achievement, pretest posttest to measure critical thinking skills. This research was conducted in 2 cycles.

Collaboration Skills

Students' collaboration skills are measured using a questionnaire. The results of the collaboration skills questionnaire before (pretest) and after (posttest) learning took place on the material of the earth and solar system using the discovery learning model with the TaRL approach in cycle I presented in Table 2.

Table 2. Results of Pretest-posttest Statistical Data and N-Gain to Measure Collaboration Skills in Cycle I

Statistic	Pretest	Posttest	N-Gain	Category
Min	0	0		
Max	97	98		
Amount	2437	2452		
Average	74	74	**0.025**	**Low**

Based on Table 2, it can be seen that the pretest results have the largest value of 97 and the smallest value is 0 with a total of 2437 and an average of 74. While the posttest has the largest value of 98 and the smallest value is 0 with a total of 2452 and an average of 74. The completeness of critical thinking skills can be seen from the posttest results above the KKM value, which is 78 while the average obtained in cycle 1 is 74, so that the learning achievement results are not as expected by the teacher. The N-gain result of critical thinking ability was 0.025 in the high category but there were still some data that were not valid because a negative N-gain value was found. This research must be continued in cycle II because it has not yet reached the completeness expected by the researcher.

Table 3. Results of pretest-posttest to measure collaboration skills in cycle 2

Statistic	Pretest	Posttest	N-Gain	Category
Min	40	53		
Max	80	93		
Amount	1860	2420		
Average	56	73	**0.413**	**Medium**

Based on Table 3, it can be seen that the pretest results have the largest value of 80 and the smallest value is 40 with a total of 1860 and an average of 56. While the posttest has the largest value of 93 and the smallest value is 53 with a total of 2420 and an average of 73. The completeness of critical thinking skills can be seen from the posttest results above the KKM value, which is 78 while the average obtained in cycle II is 73, so that the learning achievement results are not as expected by the teacher. This research must be continued in cycle III because it has not yet reached the completeness expected by the researcher.

Based on the analysis of collaboration data, it can be concluded that there was a very significant increase in collaboration skills from cycle 1 to cycle 2. The learning method or strategy applied in cycle 2 succeeded in increasing the average collaboration skills of students substantially and overcoming the problem of decreasing collaboration skills that occurred in some students in cycle 1.

The increase in average N Gain from 0.0461 (low category) to 0.413 (medium category) shows that the intervention or improvement of discovery learning model with TaRL approach has a big positive impact. This indicates that learners develop better collaboration skills, such as communication, teamwork, and joint problem solving.

The results obtained are in line with research conducted by Sari & Tahir, (2024) The results showed that collaboration skills with the Discovery Learning model can improve the collaboration skills of seventh grade students at SMP N 1 Pallanga. This is shown from the results of the percentage of completeness which was originally 70.74% in cycle 1 to 87.18% in cycle II.

Recent research indicated that the discovery learning model significantly enhanced students' collaboration skills. The findings revealed that the percentage of students demonstrating effective collaboration skills in the pre-cycle was 45%, with an average score of 68.33. This figure increased to 76% with an average score of 78.48 in Cycle I and rose to 88% with

an average score of 87.58 in Cycle II. Based on these results, implementing the Discovery Learning model effectively improved the collaboration skills of grade VIII B students at SMP Negeri 4 Semarang (Afdilla et al., 2024).

Collaboration skills are needed in science learning because science learning does not only focus on knowledge of facts, principles but also learning discovery (Marhamah et al., 2023). According to Sari & Tahir, (2024)The Discovery Learning model is a discovery-based learning model that encourages learners to solve their problems. In solving problems, learners communicate and collaborate so that they can achieve the learning objectives that have been carried out.

Critical Thinking Skills

Meanwhile, to measure students' ability to think critically, the discovery learning model of the TaRL approach was used, using five description questions: pretest and posttest. The following are the results obtained by researchers in cycle I, which can be seen in Table 4.

Table 4. Results of pretest - posttest to measure critical thinking skills in cycle I.

Statistic	Pretest	Posttest	N-Gain	Category
Min	40	53		
Max	80	93		
Amount	1860	2420		
Average	56	73	**0.413**	**Medium**

Based on Table 4, it can be seen that the pretest results have the largest value of 80 and the smallest value is 40 with a total of 1860 and an average of 56. While the posttest has the largest value of 93 and the smallest value is 53 with a total of 2420 and an average of 73. The completeness of critical thinking skills can be seen from the posttest results above the KKM value, which is 78 while the average obtained in cycle 1 is 73, so that the learning achievement results are not as expected by the teacher. The N-gain result of critical thinking ability is 0.413 in the medium category. This research must be continued in cycle II because it has not yet reached the completeness expected by the researcher. Meanwhile, the pretest-posttest results for measuring critical thinking skills in cycle II can be seen in Table 5.

Table 5. Results of pretest - posttest to measure critical thinking skills in cycle 2

Statistic	Pretest	Posttest	N-Gain	Category
Min	47	87		
Max	87	93		
Amount	2173	2707		
Average	66	82	**0.474**	**Medium**

Based on Table 5, it can be seen that the pretest results have the largest value of 87 and the smallest value is 47 with a total of 2173 and an average of 66. While the posttest has the largest value of 93 and the smallest value is 87 with a total of 2707 and an average of 82. The completeness of critical thinking skills can be seen from the posttest results above the KKM value of 78 while the average obtained in cycle II is 82, so that the results of learning achievement are following what the teacher expects. The N-gain result of critical thinking ability is 0.474 in the medium category. The research has reached the completeness expected by the researcher.

Based on the analysis of critical thinking data, it can be concluded that there was a significant increase in critical thinking skills between cycle I and cycle II. The increase in average N Gain from 0.5171 to 0.6318 indicates that the intervention or discovery learning model with TaRL approach applied is effective in improving learners' overall critical thinking skills. Some learners showed excellent improvement, while others still experienced problems.

Although the overall results were positive, there is room for improvement, especially in addressing the variability of critical thinking skills among learners and efforts to help learners demonstrate improved critical thinking skills. More personalized learning strategies and deeper analysis of the factors that influence the development of critical thinking skills may be needed to improve the effectiveness of future interventions.

The results obtained are in line with research conducted by Safitri & Mediatati, (2021) The results from Cycle I showed that students' critical thinking skills in the high category were 3%, medium category 37%, low category 42%, and very low category 8%. In Cycle II, an improvement was observed, with students' critical thinking skills in the very high category at 54%, high category 30%, medium category 8%, low category 8%, and none in the very low category. The completion rate of learning outcomes in Cycle I, meeting the minimum passing criteria (KKM), was 3 students or 13%, while 21 students or 87% did not meet the KKM. In Cycle II, 20

students or 83% completed the KKM, while 4 students or 17% did not. The results demonstrated that the Discovery learning model was proven to improve students' critical thinking skills and learning outcomes.

The results of other studies showed that the discovery learning model had a positive effect on the critical thinking skills of fourth-grade students at SDN 15 Mataram. With a significance value (2-tailed) of 0.000, these results were considered significant (Aprianingsih et al., 2023). This indicated that the discovery learning model encouraged students to actively participate in the learning process, solve problems, and acquire knowledge independently, thereby improving their critical thinking skills.

From the results of the above research, it is known that to hone students' critical thinking skills, an innovative learning model, method, strategy or approach is needed so that students are interested and motivated in participating in learning. Teachers who have implemented a strategy, model, method, or learning approach that can hone students' critical thinking skills, it will be easier to achieve optimal learning objectives.

Learning Achievement

Measurement of learning achievement results was carried out using pretest and post test in the form of multiple choice of 10 questions with a total of 33 students in class VII D. The pretest was conducted before treatment while the post test was conducted after treatment. Table 6 below presents the pre-test-post test results in cycle 1.

Table 6. Result of pretest-posttest to measure learning achievement in cycle 1

Statistic	Pretest	Posttest	N-Gain	Category
Min	40	53		
Max	87	93		
Amount	1947	2447		
Average	59	74	**0.365**	**Medium**

Based on Table 6, it can be seen that the pretest results have the largest value of 87 and the smallest value is 40 with a total of 1947, and an average of 59. While the posttest has the largest value of 93 and the smallest value is 53 with a total of 2447 and an average of 74. The completeness of learning outcomes can be seen from the posttest results above the KKM value, which is 78 while the average obtained in cycle 1 is 74, so that the learning achievement results are not as expected by the teacher. The N-gain result of learning achievement is 0.365 medium category. This research must be continued in cycle II because it has not yet reached the completeness expected by the researcher. Table 7 below presents the pretest-posttest results to measure learning achievement in cycle 2.

Tabel 7. Results of pretest - posttest to measure learning achievement in cycle 2

Statistic	Pretest	Posttest	N-Gain	category
Min	40	53		
Max	80	93		
Amount	1860	2420		
Average	56	73	**0.532**	**medium**

Based on Table 7, it can be seen that the pretest results have the largest value of 80 and the smallest value is 40 with a total of 1860, and an average of 56. While the posttest has the largest value of 93 and the smallest value is 53 with a total of 2420 and an average of 73. The completeness of learning outcomes can be seen from the posttest results above the KKM value, which is 78 while the average obtained in cycle II is 73, so that the learning achievement results are not as expected by the teacher. The N-gain result of learning achievement is 0.532 in the medium category. Although cycle II showed positive results, this research should be continued in cycle III because there were some students who had not yet reached the completeness expected by the researcher.

From the results of the study, it was found that there were positive changes from cycle I to cycle II. The applied discovery learning model successfully helped to increase the average student achievement and helped the lowest-achieving students. Nevertheless, the variation in achievement between students is still quite large, so individualized attention is needed.

The increase in average N Gain from 0.4534 to 0.5171 indicates that the intervention or improvement of the discovery learning model with the TaRL approach has a positive impact. However, since the NGain value is still in the medium category, there is still potential for further improvement in the following cycles.

The positive increase in learning achievement results is in line with the results of research conducted by Aderniwati Gulo at SMK Negeri 1 Lolowa'u, South Nias, Indonesia. According to Gulo, (2022) The discovery learning model can involve learning activities that maximize the entire ability of students to search and

investigate history systematically critically and logically so that they can find their own knowledge attitudes and skills as a form of behavior change, thus increasing learning outcomes can be more optimal because these students feel motivated to improve the learning outcomes that have been achieved before. This is also in line with the results of research obtained by Danial & Amin, (2024), there is an increase in learning outcomes in students. In the pre-cycle stage, only 17.65% of students reached the Minimum Completion Criteria (KKM). In cycle 1, the percentage of complete learners increased to 61.76%, and in cycle 2, it increased further to 88.24%. This study shows that the Discovery Learning model with the Teaching at the Right Level (TaRL) approach is effective in improving the science learning outcomes of students in class VII-4 UPT SPF SMP Negeri 2 Makassar.

Other research showed that through the discovery learning model, learners did not get bored quickly, which made them more eager to learn. Additionally, discovery learning allowed students to learn actively, creatively, and meaningfully through hands-on activities, improving their understanding and mastery of concepts (Chusni et al., 2021). Students became more enthusiastic because discovery learning presented a learning experience that was not monotonous. The discovery learning model improved critical thinking skills, collaborative skills, and science learning achievement more effectively than conventional learning models (Chusni et al., 2022; Nusantari et al., 2021; Usman et al., 2022). Therefore, the discovery learning model proved an alternative approach to improving students' critical thinking skills, collaborative skills, and science learning outcomes.

From the research that has been done, it is found that the Discovery Learning Model with the TaRL approach makes students more active in learning, students can really understand the concepts that have been learned, improve critical thinking skills, and learning achievement results. Thus, the Discovery Learning Model with the TaRL approach can be used as the right step to improve learning achievement results, critical thinking skills, and collaboration skills of students in science learning.

Conclusion

Based on the results of the class action research, the conclusions obtained are by analyzing the research objectives, namely the application of the discovery learning model and the TaRL approach in science subjects can improve students' critical thinking skills, collaboration skills, and learning achievement. Applying the discovery learning model with the TaRL approach improves critical thinking skills, collaboration skills, and student learning achievement. However, further adjustment and development are still needed to overcome the variability of results among learners and maximize the potential for improvement in all aspects of learning. The discovery learning model with the TaRL approach shows good potential to be applied more widely in science learning while still paying attention to student's needs and making adjustments based on specific conditions in the classroom. Additionally, learning activities in the process can be made more engaging to ensure that learning objectives are met effectively. The findings of this classroom action research may serve as a reference for future researchers.

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