

# Improving collaboration skills through the implementation of differentiated learning with a discovery learning model in junior high schools

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## Abstract

The learning process designed and implemented by science teachers has not been optimal in improving collaboration skills. This class action research aims to analyze the improvement of collaboration skills through the implementation of differentiated learning using cooperative learning models. The subjects of this class action research were 30 students of class VIIA SMPN 27 Surakarta. This research was conducted in the odd semester of the 2023/2024 academic year with the material of the Nature of Science and the Scientific Method in Natural Science subjects. The research instruments used were rubrics and questionnaires for collaboration skills observation sheets and learning implementation observation sheets. The steps of this research include the action planning stage, the action implementation stage with observation, and the reflection stage. The results showed that the implementation of differentiated learning using the discovery learning model improved collaboration skills as indicated by an increase in the percentage of collaboration skills scores. The percentage value of collaboration skills in the pre-cycle was 58.88% in the moderate category, in cycle I was 69.21% in the high category, and in cycle II was 73.33% in the high category. Differentiated learning using the discovery learning model improves collaboration skills.

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## 1. Introduction

World civilization has entered the 21st century. Numerous studies show that a broad set of 21st century skills are instrumental in various fields of work in the national economy. In the field of education, developing 21st century skills is a requirement. In the digital age, it has become imperative that individuals develop 21st century skills to ensure quality. Education that is responsive to 21st century skills can promote long-term learning opportunities for everyone (Perdue, 2020).

The Partnership for Twenty-first Century categorizes 21st century skills into three categories. Category (1) learning and innovation skills including creativity, innovation, critical thinking, problem solving, communication and collaboration, category (2) information, media and technology skills, including 3 types of literacy covering information, media, and information and communication technology or ICT, category (3) life and career skills there are many kinds including being able to adapt, take initiative, social and cross-cultural skills, productivity and accountability, being a leader and responsibility (Celik et al., 2024; Thornhill-Miller et al., 2023).

Assessment and Teaching of the Twenty-First Century Skills known by the ATC 21 categorizes ten skills in four categories. Category (1) ways of thinking includes creativity, innovation, critical thinking, problem solving, action taking, metacognition, category (2) ways of working includes communication and collaboration, category (3) tools for working includes information literacy and ICT literacy, category (4) living in the world includes citizenship, life and career, and personal and social responsibility. The framework identifies measurable dimensions of skills: knowledge, skills, attitudes, values and ethics (Grii & Care, 2015).

Learners in the 21st century are expected to be competent according to the demands of the times. The competencies that learners must master are communication, collaboration, critical thinking, and creativity (Kembara, et al., 2019). Each of these competencies has an important role for learners and can be improved through an activity or action. One of them is collaboration competency. The American Statistical Association (ASA); the National Academies of Science, Engineering, and Medicine (NASEM) concluded that learning collaboration skills is essential for statistical practice for students (Vance & Smith, 2019). The American Statistical Association considers that collaboration skills are part of the personal and professional skills along with communication, career planning and leadership that are key to the success of data scientists (Palmer, 2014).

In science learning there is a discovery process, therefore collaboration skills are needed in the discovery process (Saab et al., 2005, 2007). Collaboration skills can be analyzed by teachers as researchers or researchers while at school. In the findings obtained by Li et al (2023), explained that students' collaboration skills are still categorized in the low range. Learners appear to be less involved in group discussions, less sharing of opinions, less open thinking, less sharing of group roles and responsibilities, and less motivation to learn. Low collaboration skills are usually due to learning that is fixated on one type of learning resource, the teacher is the only source of knowledge in the classroom, the teacher uses a learning model that causes students to not know how to collaborate with other students (Berlin & Carlström, 2014).

Based on the observation in class VII A SMP Negeri 27 Surakarta, it is known that students' collaboration skills are low. The data found during the observation is that students have not been able to provide ideas that become a reference in the discussion. Learners lack initiative in finding learning resources. Completion of group assignments is not on time because students lack time management. The data findings became the basis for researchers in concluding that students' collaboration skills were still low.

The condition of students with collaboration skills in the low category requires action to overcome these problems. Differentiated learning with a discovery learning model can be the right decision to solve the problem of low collaboration skills of students.

The first step to overcome the problem appropriately is to identify the characteristics of students first. The current Merdeka curriculum is related to learning strategies that are balanced with the personalities of students (Marisa, 2021). The main learner characteristic for educators to understand is learning style. The current Merdeka Curriculum accommodates learning style characteristics in its application (Dwi Cahya et al., 2023). Differentiated learning is learning that facilitates and recognizes the diversity of learners in balance with learners' readiness, preferences, and learning styles (Porta et al., 2024). Differentiated learning with four aspects, namely content, process, product, and learning environment, is able to foster creativity, critical thinking, collaboration, and communication according to the characteristics (readiness, learning style, and interest) (Khristiani et al., 2021).

Differentiated learning can be implemented using cooperative learning models (Awada & Faour, 2018). The discovery learning model has characteristics such as discovery, problem solving to form knowledge; learner-centered activities; and activities that combine new and old knowledge of learners (Aldalur & Perez, 2023). The discovery learning model has six main steps: (1) Stimulation, leading to a willingness to solve problems, (2) Problem statement, identify as many problems as possible and then one of them is formulated as a hypothesis, (3) Data collection, collect as much information as possible to show the truth of the hypothesis, (4) Data processing, process the data to interpret it, (5) Verification, carefully examine the truth of the hypothesis associated with the results of data processing, (6) Generalization, agree on the conclusion which is the final result of discovery (Syah, 2017). In previous findings conducted by Balqist et al (2019), in class VII junior high school related to the implementation of the discovery learning model for efforts to improve collaboration skills and higher order thinking of students has been successful. The syntax of the discovery learning model is claimed to be able to improve collaboration skills and higher order thinking skills. The claim is based on real evidence that in the syntax there are activities to formulate problems, make proposals and test hypotheses, to draw conclusions.

Based on the description of the problem, it is necessary to conduct classroom action research in the classroom by using differentiated learning with discovery learning to help students improve their collaborative skills.

## 2. Method

The type of research is Classroom Action Research. This research was conducted in the first semester of the 2023/2024 school year in July to August 2023. The research was conducted on science subjects Chapter 1 and Chapter 2. The research subjects were 30 students of class VIIA SMPN 27 Surakarta. The research instruments were collaboration skill observation sheets and learning implementation observation sheets. This research consists of Cycle I and II.

The stages of this research include action planning, action implementation with observation, and reflection (Rabgay & Kidman, 2024). At the action planning stage includes identifying problems, finding solutions, preparing learning devices and research instruments. At the action implementation stage is to carry out class action by carrying out differentiated learning using the discovery learning model then students fill out a questionnaire observation sheet for collaboration skills. At the observation stage is to observe during the learning process with the guide of the learning implementation observation sheet. Finally, the reflection stage is to evaluate based on the results of the questionnaire and observation of the implementation of learning activities. The reflection results obtained from Cycle I are then used as the basis for making follow-up at the planning stage in Cycle II. In Table 1 below are the stages of class action research.

**Table 1. Stages of Classroom Action Research**

No	Stages	Action
	Cycle I	Problem Identification Action Planning I Implementation of Action I and Observation Reflection
	Cycle II	Problem Identification Action Planning II Implementation of Action II and Observation Reflection

This study applied a rubric with 5 aspects and indicators that have a scoring of 1-4. In this study, all aspects with 4 scoring indicators were used and then broken down into 12 similar statements in Table 2.

**Table 2. Collaboration Skills Rubric**

No	Aspect	Action
	Contribution	I contribute to the group discussion by giving ideas. I contribute to the group discussion by leading the discussion.
	Time Management	I am responsible for completing tasks within the agreed time. I strive to always complete tasks in a timely manner.
	Problem Solving	I try to find ideas to answer the problem by myself. I try to convey my ideas to answer the problem.
	Working with Others	I ask my friends when it is difficult to find a solution to a task. I listen well to other people's opinions. I help my friends in the group to complete group tasks. I cooperate with friends to agree on task completion.
	Inquiry Techniques	I use more than one learning resource. I record detailed information for task completion.

Collaboration skills questionnaire data was analyzed using descriptive qualitative data analysis techniques. The questionnaire results were analyzed using a percentage form with the formula:

$$\text{Percentage score} = (\Sigma \text{ score}) / (\text{maximum score}) \times 100\%$$

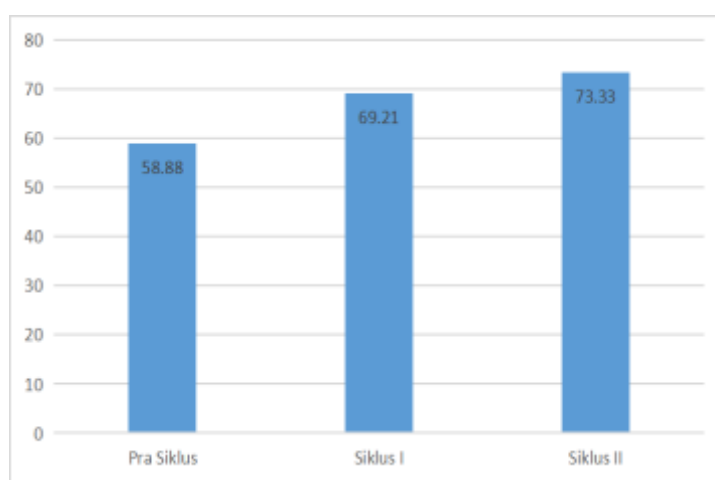
The criteria for scoring collaboration skills using Arikunto's (2009) scoring criteria can be seen in Table 3. This study targets the success indicator by achieving the value of collaboration skills in the high category.

**Table 3. Criteria for the Percentage of Collaboration Skills**

No	Score	Category
	80% - 100%	Very High
	60% - 80%	High
	40% - 60%	Fair
	0% - 40%	Low

### 3. Results and Discussion

This research was conducted by implementing differentiated learning using the discovery learning model. Data on students' collaboration skills were obtained from a questionnaire instrument in each meeting of each cycle. In Figure 1 below is the average percentage of collaboration skills from pre-cycle to cycle II.



**Figure 1. Average Percentage of Collaboration Skills from Pre-Cycle to Cycle II**

Based on the results presented in Figure 1, it shows an increase in collaboration skills. The percentage of the average value of collaboration skills at pre-cycle was 58.88%, including the moderate range. In cycle I, the percentage of the average value of collaboration skills was 69.21% including the high range. The percentage increase was 10.33%. In cycle II, the increase occurred by 4.12% with a percentage of the average value of collaboration skills of 73.33% including in the high category. The percentage for each aspect of collaboration skills is presented in Table 4 in detail.

**Table 4. Recapitulation of Collaboration Skills with Percent Units (%)**

Aspect	Pre-Cycle	Cycle I	Cycle II
Contribution	57.50	64.17	69.17
Time Management	59.58	75.00	79.58
Problem Solving	55.42	64.17	69.58
Working with Others	60.63	76.04	77.50
Investigation Techniques	61.25	66.67	70.83
Total Average	58.88	69.21	73.33

The results showed an increase for each aspect of collaboration skills. In detail, the percentage of the Contribution aspect is 57.50% in the pre-cycle rose to 64.17% in cycle I and then rose to 69.17% in cycle II, meaning that there is always an increase. The first increase was 6.67% and the second increase was 5%. The percentage of Time Management aspects increased from 59.58% in the pre-cycle to 75.00% in cycle I then rose to 79.58% in cycle II. The first increase was 15.42% and the second increase was 4.58%. The third aspect, namely Problem Solving, also experienced an increase

in percentage from 55.42% during the pre-cycle to 64.17% in cycle I and then to 69.58% in cycle II. The first increase was 8.75% and the second increase was 5.41%. The increase also occurred in the fourth aspect, namely Working with Others, the percentage at the beginning of the pre-cycle was 60.63% to 76.04% in cycle I and then changed to 77.50% during cycle II. The initial increase was 15.41% and the second increase was 1.46%. The last aspect, namely Investigation Techniques, also increased from pre-cycle 61.25% to 66.67% during cycle I and then to 70.83% during cycle II, so there was an initial increase of 5.42% and a second increase of 4.16%. Based on the percentage details, it can be seen that there is always an increase in percentage. The criteria for assessing students' collaboration skills are presented in Table 5 below.

**Table 5. Criteria for Learner Collaboration Skills**

Criteria	N0	%	N1	%	N2	%
Very High	0	0	8	26,66	10	33,33
High	18	60	15	50	15	50
Fair	12	40	7	23.33	5	16,66

N0 is the quantity of learners in the pre-cycle. N1 is the quantity of learners in cycle I and N2 is the quantity of learners in cycle II. Initially there were no learners who were included in the Very High criteria, then there were 8 learners and finally there were 10 learners. In the High criteria, 18 learners in the pre-cycle then became 15. This decrease was because there were learners who were initially in the High criteria then entered the Very High criteria. The Sufficient criteria in the pre-cycle were a total of 12. The Sufficient criteria then became 7 and finally became 5.

The action in Classroom Action Research is that students choose one of three types of measurement experiments that are of interest as an application of differentiated learning. Learners are also identified with their learning styles and initial abilities. Learning grouping is based on the learning needs data. Learning is carried out using the discovery learning model.

Cycle II focuses more on the aspects of Contribution and Problem Solving because the percentage is lower than other aspects. Based on the observation of learning implementation, there were learners who were less focused on their own groups, thus reducing the contribution and focus on problem solving. There are different learner worksheets for groups. This worksheets has different activities so that students focus on discussion activities in the group. The reference for providing activities in different worksheets is based on problem solving ability.

There are factors that can make learners' collaboration skills improve well. These factors come from differentiated learning and discovery learning models.

Differentiated learning can facilitate 4C skills, starting from communication, critical thinking, creativity, and collaboration (McKoy & Merry, 2022). In this study, applying differentiated learning has succeeded in improving students' collaboration skills to reach High criteria.

Based on the observation of learning implementation, the application of the discovery learning model runs well in each syntax. The first syntax is stimulation, students can discuss with group members to answer the phenomena presented by the teacher. In this activity, collaboration skills appear in the aspect of Working with Others. This is in line with Syarofah (2023) that the stimulation syntax contributes to bringing up an attitude of respect in discussing with friends in one group (De Jong & Van Joolingen, 1998).

In the second syntax, namely problem statement, students have also been able to do it well. This syntax also succeeded in bringing up collaboration skills because learners discussed to ask as many relevant questions as possible. This finding is in line with Olde Bekkink (2015) that in formulating questions group members can contribute and accommodate each other's opinions.

In the third syntax, namely data collection, students and their groups collect data to solve problems. This raises the activeness of learners to contribute in finding out. This is in line with Dalgarno (2014) that discovery learning makes them active and creative.

In the fourth syntax, namely data processing, learners are active in investigating and solving problems. Learners process data and test the hypothesis proposed. Comparable to Brinda (2006) that the discovery learning model creates activeness in investigating and discovering until the results of the investigation and discovery will be easily remembered.

In the fifth syntax, namely verification, students utilize the time available to find alternative information and dare to make decisions to present in front of the class. In this activity all group members contribute well. This shows the collaboration skills of learners. This is in line with Hsieh (2017) that this syntax raises responsibility, contribution and respect for responses.

In the sixth syntax, namely generalization, learners work together to produce the final conclusion of the entire process they have taken. To achieve this stage, of course, students have gone through all syntax by managing time in a directed manner. This syntax shows collaboration skills, namely contribution, time management and cooperation. In accordance with Jurow (2004), it is necessary to work together and utilize time effectively and discuss with each other to make decisions.

### 3.1. Conclusion

Based on the results and discussion, it is concluded that differentiated learning using the discovery learning model can improve collaboration skills. The increase in collaboration skills is indicated by a change in the percentage of the average value of collaboration skills that are getting higher. The value of collaboration skills is getting higher after the action is given. Initially worth 58.88% then 69.21% finally 73.33%. The final result is High criteria. It is concluded that differentiated learning by applying the discovery learning model is a solution to improve collaboration skills.

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