



## An Analysis of Students' Collaboration Skills in Science Learning Through Inquiry and Project-Based Learning

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**Abstract:** Collaboration skills are essential for students when facing the working world in 21st-century society. The study aims to determine students' collaboration skills through inquiry and project-based learning in science. The descriptive method was implemented with surveys and interviews. The participants were 175 students from Junior High School. Data collection was carried out using collaborative skill observation sheets and an interview guide. The results showed that, in general, the collaboration skills of participants were categorized as high regarding the indicators of collaboration skills. The indicators consisted of contributing to group discussions (72.57 percent), working effectively in group discussions (77.14 percent), communicating in group activities (74.86 percent), and having responsibility for completing group assignments (75 percent). Therefore, teachers are advised to apply inquiry and project-based learning in science to improve student collaboration skills.

## INTRODUCTION

The 21st century is marked by various changes in various aspects of life due to information and communication technology influencing students' skills (Chung et al., 2016; Kumar Basak et al., 2018; Worrell et al., 2015). The problems faced by students are increasingly varied and complex. To cope with the increasingly complex problems in a fast-changing society, educators must nurture learners with 21st-century skills to think and act like real scientists, asking questions, making hypotheses, and carrying out investigations (Kelley & Knowles, 2016). Students' skills in the 21st century are not enough to master the knowledge or metacognitive but must think critically, creatively, communicate and collaborate (Greenstein, 2012;

Hidayat et al., 2019; Redhana, 2019; Vithanapathirana & Nettikumara, 2020).

The definitions of 21st-century skills can vary according to the suggestions of different authors. For example, the study conducted by Makrakis and Kostoula-Makrakis took as a starting point the basic skills known as "4C's" (Critical Thinking, Communication, Collaboration, and Creativity). These skills will enable students to prepare for 21st-century society through deep learning in daily life (Germaine et al., 2016; Ghobrini, 2020). Students need to adapt to various changes and challenges in the globalization era by developing 21st-century skills.

The development of the 21st century must be followed by the development of the skills of students. The improvement of the 21st-century skills of

students is one of them influenced by teachers (Hampson et al., 2011). Teachers are a significant factor in education success (Hattie & Timperley, 2007; Meilia & Murdiana, 2019; Yuliani & Lengkanawati, 2017). If the teachers are qualified, the students will also be qualified. Changes in learning must be carried out by professional teachers so that students can have the ability to face changes that occur in the 21st century. The professional development of teachers needs to pay attention to the social aspects of learning (Voogt et al., 2015). Teachers need to have various knowledge and abilities to convey material. Still, teachers must develop various social skills required by students to respond to the various dynamics in society in learning.

Collaborative skill is one of the 21st-century social skills important for teachers to develop. Collaboration enables groups to make better decisions than individually (Bialik, M., & Fadel, 2015; Kathleen, 2016; Kropp et al., 2016; Le et al., 2018). A learning process in planning and working in groups, dealing with differences of opinions in discussions, and participating in discussions, such as giving suggestions, listening to other people talk, and supporting other people's opinions, are included in collaboration skills (Greenstein, 2012). Collaboration is a specific social interaction and learning process where group members can actively and constructively solve problems (Lee et al., 2015). Collaboration skills are the ability to participate in every activity to foster relationships with others, respect mutual relationships, and teamwork to achieve the same goal (Le et al., 2018). Collaboration skills are also related to working effectively, an attitude of responsibility, and commitment to achieve common goals (Hidayati, 2019). Collaboration skills can exchange thoughts, ideas, and feelings between students at the same level (Dewi et al., 2020). Thus, collaboration skills are a person's ability to work effectively,

exchange ideas, communicate, be responsible, committed, and respect each other in groups to solve problems efficiently and achieve the same goals.

The era of globalization has an impact on the social life of students. Students tend to prefer interacting with other people via the internet. Face to face is only done if there is a very urgent need. Social life like this will impact the mindset of students when entering the world of work. They will find it difficult to interact or develop working relationships with other people competently even though collaboration must be completed quickly and goals can be achieved optimally (Moradian et al., 2020; Tîrziu & Vrabie, 2015).

For this reason, students have urgent collaboration skills as provisions in entering the world of work later. Collaboration skills are critical to working together in different groups as provisions for facing the globalization era of the 21st century (Muiz et al., 2016). Kevin Dunbar identified shared goals and constructive exchange from multiple perspectives as two key indicators of successful scientific collaboration (Dunbar, 2000).

Teachers' collaboration skills are reflected in the learning scenario in the Lesson Plan if the teacher uses a learning model according to the 2013 curriculum. The preliminary study results obtained information that the teacher had used the learning model suggested in the 2013 curriculum, namely inquiry-based learning, problem-based learning, project-based learning, cooperative learning, and collaborative learning. The lesson plan for science subjects illustrated that collaboration skills had been developed in science learning by teachers in Junior High Schools. The learning steps in the science lesson plan use the inquiry learning model and have written: "students in-group /collaborate to make elaboration, investigation and data collection." Then in project-based learning written "students in groups

working on projects." Collaboration between students can create productive cooperation, and students become responsible for their duties.

Based on the studies and facts above, collaboration skills can be developed or trained in learning so that students become professionals when they enter the real world of work. Collaboration skills are professional skills that can be learned and taught (Vance & Smith, 2019). Teachers can develop collaborative work in science learning at Junior High School students, and teachers have done this through inquiry learning and project-based learning. Collaboration skills will form character learners, namely mutual respect, respect, tolerance, responsibility, honesty, and openness (Apriono, 2013) in learning. Thus, the analysis of collaborative skills in science learning in junior high schools through collaborative skills instruments is very urgent, considering that there is no clear description of students' collaborative skills in science learning in junior high schools. This study aims to determine students' collaboration skills in science learning through inquiry and project-based learning.

## METHOD

The quantitative descriptive method with a survey and interview was implemented. The participants in this study were 175 students from junior high schools in Pontianak, Indonesia.

The data collection instrument used was a collaborative skill questionnaire which contained several statements that match the indicators. We developed the questionnaire based on a synthesis of supporting theories of collaboration skills. The synthesis results were made conceptual definitions, then indicators of collaboration skills were formulated from these conceptual definitions. Observation items referred to the indicators of collaboration skills. A theoretical validation was carried out to obtain the accuracy of measuring collaboration skills using observation sheets. The validity of the test indicated that the level of accuracy of a test against what the test measures (Hairida, 2017). The instrument's validity was carried out by examining two evaluation experts, both qualitatively and quantitatively. Qualitative expert examination results are shown in Table 1.

**Table 1.** Qualitative Expert Examination

Item	Expert 1	Expert 2
1	Adding observations to students to "do their best to achieve group goals" on indicators that contribute to group discussions	The observation on indicator two is added with the word "desire" to differentiate between ordinary students and those who have collaborative skills.
2	The observations in indicator two are added to the positive interdependence, meaning that team members share information, remind each other, and help each other solve problems so that discussion/work becomes effective.	Indicator 2 to the observation is added with the sentence... "to achieve the same goal" because working effectively in collaboration achieves the same goal.
3	Observation on indicator three is added, "ask a friend if you find a problem."	Added activity in group discussions; for example, team members ask others.
4	Responsible is added... "completion of group assignments."	Added completion of tasks on time according to the provisions for observation 4.

Quantitative and qualitative expert test results were used to revise the grid, rubric, and collaboration skill instrument.

The following is the grid and rubric of the collaboration skill instrument after testing.

**Table 2.** Grid and Collaboration Skill Instrument Rubric

No	Indicators	Observation
1.	Contributing to group discussions	<ol style="list-style-type: none"> <li>1. Providing suggestions in group discussions to complete group assignments.</li> <li>2. The desire to do the best for the group in achieving group goals.</li> </ol>
2.	Working effectively in group discussions	<ol style="list-style-type: none"> <li>1. Working as a team in completing tasks to achieve the same goals.</li> <li>2. Doing tasks by sharing tasks and positive interdependence to achieve the same goal.</li> </ol>
3.	Communicating in group activities	<ol style="list-style-type: none"> <li>1. Respected each other's opinions between group members in completing tasks.</li> <li>2. Asked friends if you find problems.</li> <li>3. Compromised in making decisions if there are differences of opinion in decision making.</li> </ol>
4.	Having responsibility for completing group assignments	Group members were responsible for completing tasks on time according to the provisions.

The data was collected from January - March 2020. The study started in the 2020/2021 academic year utilizing inquiry and project-based learning methods in science. The data analysis activity referred to the research objective to describe the extent to which students' collaboration skills in science learning at Junior High Schools. The data obtained was in the form of numbers from the number of observations and interviews of indicators of collaboration skills. Furthermore, the data were grouped according to the indicators of collaboration skills. The results of the observations were calculated for each number and percentage for each indicator of collaboration skills. They were grouped based on the category of collaboration skills.

## RESULT AND DISCUSSION

Quantitative expert testing using the Gregory formula (Retnawati, 2016) found that the instrument could measure students' collaboration skills by acquiring a validity coefficient of 0.97 and 0.99, respectively. The collaboration skill instrument was suitable for measuring

collaboration skills in science learning among junior high school students.

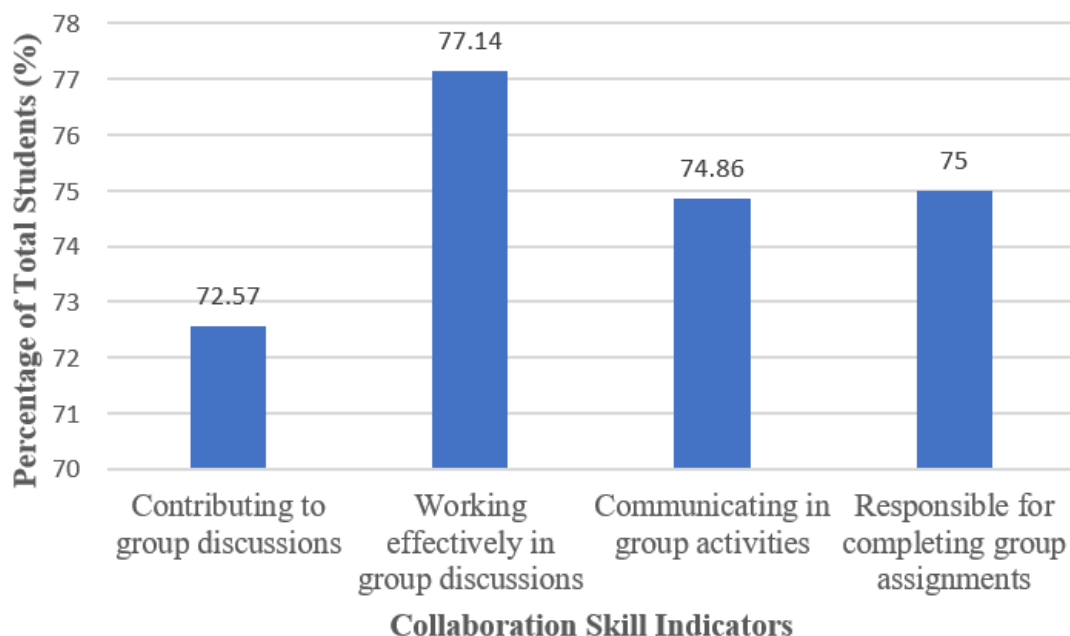
The result of the study informed that the percentage of all indicators of collaboration skills was not much different. All of them were in the high category (see Table 3).

**Table 3.** Category of Collaboration Skills Criteria (Riduwan, 2013).

Criteria	Percentage
Very High	81-100
High	61-80
Moderate	41-60
Low	21-40
Very Low	0-20

Learning using the inquiry model and project-based learning developed by teachers was one of the driving factors for high overall collaborative skills. In inquiry and project-based learning, students developed logical, critical, and systematic thinking skills about facts, concepts, and principles (Hairida, 2016). Many activities will make students have high curiosity, convey opinions, and find answers by asking others to convey the results (Rati et al., 2017). Therefore, utilizing these models during science

learning can affect students' collaboration skills.



**Figure 1.** Collaboration Skills Data Analysis

The observation was conducted while students were doing an investigation or finding answers. The students were asked to work together or collaborate with their groups. Thus, the assignments given by teachers could be completed on time, according to the provisions, and maximum results. Then when learning acids, bases, and salts in the activity of investigating acids, bases, and salts using artificial and natural indicators, it is seen that students in groups carry out activities to complete Student Worksheets. Jeong and Chi (Jeong & Chi, 2007) study corroborated that knowledge equality can be achieved because group members experience the same environmental conditions or collaboratively solve problems. Fung, Hung & Lui (Fung et al., 2018) also argued that group work consisting of effective strategies improved constructing their shared conceptual knowledge in science. Group members worked well and cared for each other professionally and personally, had common goals, and were passionate about the science done if group

members had collaboration skills (Cheruvilil et al., 2014).

Project-based learning in science learning carried out by teachers can also increase students' collaboration skills. It is in line with Saldo & Walag (Saldo & Walag, 2020) proved significant improvement in collaboration skills was shown in the project-based learning method. The stages of activities in project-based learning could train students' collaboration skills. For example, when making a product, students were asked to work in groups to create a mixed separation experimental project according to the selected method (filtering, distillation, evaporation, and sublimation). In this activity, each team member needed to compromise about the project to be made. Next, a presentation on the project design was carried out for each group. Each group divided the tasks for each member to convey certain parts of the resulting product design. The result of this observation was following the project-based learning stage. In submitting a project report, each group

questioned and answered their respective projects (Musa et al., 2012). This activity supported collaboration skills, especially mutual respect and compromise, cooperation, responsibility, and contribution.

The indicator "contributing to group discussions" is in the high category (72.57 %), indicating that group members have given ideas in completing tasks/projects. Each group member tried to complete the task/project with the best results compared to other groups. Collaborative teamwork enables students to achieve extraordinary results (Scarnati, 2001). Observations showed that group members who did not contribute to their group would impact their achievements. The group could not achieve the best result in completing the project.

Group work would not be successful if it was not supported by team member collaboration because collaboration was related to a person's ability to work together to achieve common goals (Dewi et al., 2020). The result of this study is in line with the results of observations on the indicator "work effectively in a team" is in the high category (77.14 %), and the highest score is compared to other indicators of collaboration skills. Successful groups worked as a team to complete tasks to achieve the same goal. The observation result showed that the group was successful if the group members did not do the tasks assigned by the teacher individually. In inquiry learning, it appears that students investigate the properties of acids, bases, and salts of a substance using artificial and natural indicators together. Dividing the tasks into each group, but the work is not individual, but rather help each other if someone has difficulties. Likewise, in completing a mixed separation experimental project, group members share tasks or work with each other. Still, if team members have difficulty, other

members will provide ideas/opinions/assistance.

The percentage of indicators "communicating in group activities" is in the high category (74.86 %). Good communication in group work needs to be developed in group discussions to avoid conflict in group discussions. Soft communication skills are the first-order skills from other soft skills required by students (Patacsil & Tablatin, 2017). Good communication can be developed in the activities in inquiry and project-based learning. For example, when testing the results, group members discuss the feasibility of projects made in groups and create product reports presented to others outside the group. In addition, at the learning experience evaluation stage, group members submitted product reports while other group members responded. Both of these activities can train students how to communicate well with others. Mutual respect for opinions between group members, asking other group members, and making decisions if there are differences of opinion in completing tasks, are developed at both stages. Present work activity can train creativity and collaboration skills, namely being responsible for assigned tasks, collaborating with others, and communicating well (Machin, 2014).

The study conducted by Haris (2016) proved that group learning in project-based learning meant that each participant had the same responsibility to complete the tasks given by the educator. The results of data analysis showed that the percentage for the indicator "responsible for completing group tasks" was in the high category (75 %). The responsibility for completing group assignments got students to focus during group discussions while working on assignments/projects because they want assignments to be collected on time and according to provisions. Focusing on work or carrying out tasks, then time

became efficient (Carrió-Pastor & Skorczynska, 2015).

Based on the facts that occur in inquiry and project-based learning activities, it can be concluded that students can learn collaboration skills by providing a learner-centered and collaborative learning environment.

## CONCLUSION

The utilization of inquiry and project-based learning models in science learning can develop students' collaboration skills. It is caused by students being trained to develop logical, critical, and systematic thinking skills and included activities that make students have high curiosity, convey opinions, and find answers by asking other people to convey the results made to others. Indicators of collaboration skills contribute to group discussions (72.57 %), working effectively in group discussions (77.14 %), communicating in group activities (74.86 %), and having responsibility for completing group tasks (75 %) all belong to the high category. For this reason, teachers are expected to consistently develop collaborative skills using learning models advocated in the 2013 curriculum. Educators may also utilize inquiry and project-based learning methods that are learner-centered to develop students' 21st-century skills, especially collaboration skills.

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