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Implementation of STEAM Approach to Teach Collaboration Skills on Pollution Material in Junior High School

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ABSTRACT

4C skills are the skills needed in the 21st century, including collaboration skills. These collaboration skills are indispensable for learners in conducting 21st century learning, to face the complex challenges of the 21st century. This study aims to describe the collaboration skills of students. The type of research used is descriptive quantitative with a pre-experimental design with a one shot case study design. Analysis of collaboration skills observation data was obtained from the results of observations by determining the percentage of scores on each indicator. The intended subjects were VII grade students with a sample of VII-C class totaling 32 students at MTsN 2 Kota Surabaya. The data collection techniques used are observation during the discussion process of working on student worksheet. The results of the study obtained the collaboration skills of students at the first meeting were 68 which showed a low category, the second meeting was 73 which showed a medium category, and the third meeting was 83 which showed a high category. The conclusion obtained from this study is that students' collaboration skills have increased because of the application of the STEAM approach.

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1. Introduction

Advances in science accompanied by the opening of new insights and mindsets have a deep psychological impact on human life (Khoirunnisa & Habibah, 2020). The problems that occur in the 21st century in the era of the Industrial Revolution 4.0 which are increasingly complex provide their own challenges for the

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world of education (Sumanji, 2019). Education is expected to be able to provide skills and soft skills to students in order to form competent human resources, so that they can compete internationally (Zulaiha & Kusuma, 2020). In connection with this, it is very important for students to have various skills needed in the 21st century to compete globally. 21st century skills consisting of creative thinking, critical thinking and problem solving, communication, and collaboration or known as 4C must be possessed by students in Indonesia as a hallmark of 21st century learning (Zakaria, 2021; Zubaidah, 2020; Khoirunnisa & Sudibyo, 2023). 21st century skills require the world of education to be able to integrate knowledge, skills and attitudes, as well as mastery of Information and Communication Technology (Ayu, 2019). The 21st century requires programs that can support through new approaches that are aligned with advances in social science, science, and technology to maintain the quality of education (Temiz & Çevik, 2023). There are many learning methods that are developing rapidly by leading to the 4.0 era (technology, digital behavior) and welcoming the 5.0 or big data era (Yuliar et al., 2020). Therefore, learning is needed that can answer the challenges and demands of current developments in preparing students' abilities and skills.

Science learning focuses on mastering concepts by paying attention to the discovery process and implementation in everyday life, so that students need to have the ability to unite opinions, convey ideas, and respect each other's opinions and draw conclusions, this ability is related to collaboration skills (Fauziah & Sudibyo, 2023). Through science learning, students will also be encouraged to collaborate to solve various kinds of science problems which will ultimately refer to social, economic and humanitarian problems. Collaboration skills play a role in supporting success in learning and have a relationship in increasing students' understanding (Evans, 2020), because they can gain knowledge and experience from each other between friends in groups when learning together (Dhitasarifa et al., 2023). Collaboration skills can be assessed as low if students when doing group work tend to depend on their group members in completing tasks from the teacher and lack interaction with their group (Putri & Qosyim, 2021). Therefore, this collaboration skill is needed by students in carrying out this 21st century learning to face the challenges of the 21st century.

Etymologically, collaboration comes from the words co and labor in English 'collaborative' which has the meaning of uniting energy or increasing the ability that is used to achieve goals that have been set together (Hamzah, 2020). Collaboration is an activity carried out to solve problems or answer questions, work effectively and respectfully in teams to complete a goal, and to share responsibilities in completing a task (Intani, 2022). Collaboration skills are skills that build relationships with others to achieve the same goals in a group (Dhitasarifa et al., 2023).

Collaboration skills are very important skills in the learning process so that students can work together in groups that have a diversity of levels in solving a problem to achieve a common goal (Yanto et al., 2023). Collaboration skills are also known as a person's ability to work effectively and responsibly to make the necessary commitments to achieve common goals (Salasiah et al., 2022). Collaboration skills are needed so that students discuss with each other related to existing problems, so that they can be resolved easily and quickly (Khoirunnisa &

Sudibyo, 2023). Khoirunnisa & Sudibyo (2023) also added that, with this collaboration skill, students will be able to understand and achieve learning objectives more easily. Collaboration skills can run well if several students actively participate in doing group work (Redhana, 2019). Therefore, collaboration skills will be achieved by someone if they are able to work well with their group.

Research entitled 'Students Collaboration Skills in Science Learning' shows that learning carried out by teachers in schools has not fully emphasized aspects of collaboration skills (Ilma et al., 2022). In line with some of these studies, the results of observations made by researchers through written interview instruments related to learning conducted in class VII C, MTsN 2 Kota Surabaya, there were six out of thirty-two students who did not like learning in groups. The results of a preliminary study conducted in class VII C, MTsN 2 Kota Surabaya using an observation sheet instrument adapted from Sarifah & Nurita (2023) also showed that students' collaboration skills were not optimal. This can be seen when students' complete tasks and conduct group discussions. Not all learners participate in discussions and search for learning resources, there are learners who do not participate in communication, are passive, and do not state their arguments and depend on other friends in completing tasks. Each learner tends to be picky in choosing friends in a study group and lacks communication with their group friends in making decisions. Seeing these facts, the collaboration skills possessed by students need to be taught further through meaningful learning so that students can have good collaboration skills.

One of the meaningful learning alternatives that can be applied to develop students' competencies is through the science, technology, engineering, art, and mathematics or STEAM approach (Amelia & Marini, 2022). STEAM learning is one of the lessons that can integrate problems between fields of study in science learning (Mu'minah & Suryaningsih, 2020). Learning using the STEAM approach encourages students to work in a group to complete tasks or projects given by the teacher. The STEAM approach invites learners to carry out the problem-solving process by collaborating an idea or idea owned by each learner from a different knowledge background in a creative way, so that the same goal is found.

The STEAM approach incorporates various life problems and integrates them with knowledge, skills and attitudes into the learning process, by facilitating practical inquiry and hands-on innovative design (Jia et al., 2021). STEAM is a comprehensive learning method that can encourage learners to think more about real-world problems by combining several themes in STEAM through its application in the arts, collaborative learning environments (Mansur et al., 2022), and process-based learning, focusing on what happens in nature (Amelia & Marini, 2022). The potential for the application of STEAM in learning on environmental pollution material is very large to be implemented so that environmental pollution learning can be carried out properly (Amelia & Marini, 2022). The application of STEAM in learning environmental pollution can be implemented at the junior high school or MTs level (Musyafiatun & Hayat, 2022). Environmental pollution material raises global issues that are happening, especially in waste management problems, suitable for application in STEAM learning to train collaboration skills because it will encourage students to work together to solve a problem through a task or project given by the teacher.

The application of STEAM-approached learning is one of the suitable

strategies applied to science subjects so that students have 21st century skills, especially in collaboration skills. Through the STEAM approach, learners are trained to have soft skills that refer to five fields, namely knowledge (science), technology, engineering, art, and mathematics, which are linked to each other by raising global issues that occur in real life. Learning using the STEAM approach encourages students to work in a group to complete a task or project. This is certainly in line with Project Based Learning (PjBL) which also uses projects in learning. The project-based learning model can be chosen to be able to train students' collaboration skills because there is a process of cooperation and direct communication with others, so that learning objectives can be achieved (Ahwan & Basuki, 2023). Therefore, in this study researchers used PjBL syntax in applying the STEAM approach to science learning.

The STEAM approach invites learners to carry out the problem-solving process by collaborating an idea or idea owned by each learner from a different knowledge background in a creative way, so that the same goal is found. In a series of processes, it is important for learners to have good collaboration skills, so that the learning objectives will be achieved. STEAM is a comprehensive learning method that can encourage learners to think more about real-world problems by combining several themes in STEAM through its application in the arts, collaborative learning environments, and process-based learning, focusing on what happens in nature (Amelia & Marini, 2022). Based on the explanation of these problems, this research will focus on the implementation of the STEAM approach to teach students' collaboration skills at the Junior High School (SMP) level.

2. Method

The type of research used by researchers in conducting this research is descriptive quantitative using a pre-experimental design research design, because to determine that this research has the potential to be worthy of further investigation. While the research design used is One Shot Case Study, which uses one experimental class without a control class because researchers give treatment to students, then observe the results related to students' collaboration skills. The population in this study were seventh grade students with a sample of class VII-C, totaling 32 students, at MTs Negeri 2 Kota Surabaya, Lakarsantri, Surabaya, Jawa Timur, even semester in the 2023/2024 academic year. The research target taking technique used by researchers is purposive sampling. Data collection using collaboration skills observation sheets carried out during learning activities. Observations were carried out by 3 observers using a collaboration skills observation sheet instrument consisting of 4 indicators described by the observation criteria presented in Table 1.

Table 1. Criteria for Observation of Each Indicator

Indicator	Aspects Observed	Code
Responsible for completing work	Complete the student worksheet according to the specified time limit	A
	Discuss problem-solving and decision-making within the group	B
	Learners look for learning resources from the internet to solve problems in student worksheet	C
Compromise	Giving others the opportunity to speak	D
	Respect and accommodate the opinions of all group members	E

Indicator	Aspects Observed	Code
	Confirming answers with the teacher or other group members	F
Work productively	Read, write, give ideas, and carry out each step in the student worksheet	G
	Speak in the context of the material and speak politely to friends	H
Adapting to various activities	Able to make presentations in front of the class, and answer questions from other groups	I
	Discussing before writing answers to student worksheet or before answering questions from other groups	J

(Adapted from Sarifah & Nurita, 2023)

Test the validity of the instrument observation sheet of collaboration skills collaboration skills observation sheet instrument was carried out through the process of reviewing the instrument by one science teacher and two science expert lecturers until the instrument is feasible to use worthy of use.

The observation sheet was filled in by giving a check mark in the "Yes" and "No" columns on each observation criterion. Recapitulation of collaboration skills observation data was analyzed by calculating the percentage of collaboration skills in each aspect, through the calculation of the number of visible observation criteria divided by the number of observation criteria. The results of student collaboration skills data were then converted based on the percentage criteria in Table 2.

Table 2. Percentage of Collaboration Skills

Percentage Correct	Criteria
90-100%	Very High/Exceptional
80-89%	High/Above Average
70-79%	Medium/Average
60-69%	Low/Below Average
<60%	Very Low/Inadequate

(Slavin, 2018)

Furthermore, calculating the average value of collaboration skills of each group, through the calculation of the number of group collaboration skills divided by the number of groups, then re-categorizing the average value of group collaboration skills based on the percentage of collaboration skills through the criteria presented in Table 2.

3. Results and Discussion

Results

The collaboration skills of students are applied using the STEAM approach at each meeting, then observations are made during the discussion of working on student worksheet using the collaboration skills observation sheet. The teacher initially organizes students into study groups, then the observer makes observations with the provision that one observer will observe two groups. Data on collaboration skills of each group at the first meeting are presented in Table 3.

Table 3. Data on Collaboration Skills of Each Group at the First Meeting

Observation Criteria Code	Group					
	1	**2**	**3**	**4**	**5**	**6**
A	-	✓	✓	✓	-	✓
B	✓	✓	✓	-	✓	✓
C	✓	✓	✓	✓	✓	✓
D	✓	-	✓	-	✓	✓
E	-	✓	-	-	-	✓
F	✓	✓	✓	✓	✓	✓
G	✓	✓	✓	✓	✓	✓
H	-	✓	-	-	✓	-
I	-	-	-	-	-	-
J	✓	✓	✓	✓	✓	✓
Value	60	80	70	50	70	80
Category	L	H	M	VL	M	H
Total	410					
Average	68					
Category	Low					

Based on Table 3. shows that there is one group that cannot complete the student worksheet according to the time limit set by the teacher, namely group 1. All groups are able to discuss in problem solving and making decisions in their groups, except group 4. Then, all groups look for learning resources from the internet to solve the problems in the student worksheet. There were two groups that did not provide opportunities to speak to their friends, namely groups 2 and 4. There were only two groups that could respect and accommodate the opinions of all group members, namely groups 2 and 6. Furthermore, all groups were able to confirm answers to the teacher or other group members. All groups were also able to read, write, give ideas, and carry out each step on the student worksheet. There are two groups that can speak according to the context of the material and speak politely to friends, namely groups 2 and 5. All groups have not been able to present in front of the class, and answer questions from other groups. Then, all groups were able to discuss before writing the answers to the student worksheet or before answering questions from other groups. Furthermore, the data on collaboration skills of each group in the second meeting is presented in Table 4.

Table 4. Data on Collaboration Skills of Each Group on the Second Meeting

Observation Criteria Code	Group					
	1	**2**	**3**	**4**	**5**	**6**
A	-	✓	✓	✓	✓	✓
B	✓	✓	✓	✓	✓	✓
C	✓	-	✓	✓	✓	✓
D	✓	✓	-	-	-	✓
E	-	✓	✓	-	✓	✓
F	✓	✓	✓	✓	✓	✓
G	-	✓	✓	✓	✓	✓
H	✓	✓	✓	✓	-	-
I	-	-	-	-	-	-
J	✓	✓	✓	✓	✓	✓
Value	60	80	80	70	70	80
Category	L	H	H	M	M	H
Total	440					
Average	73					
Category	Medium					

Table 4. shows that all groups can complete the student worksheet according to the time limit set by the teacher, except group 1. All groups discuss in solving problems and making decisions in their groups. There were three groups that did not provide opportunities to speak to their group members, namely groups 2, 3, and 4. All groups were able to respect and accommodate the opinions of all group members, except groups 1 and 4. All groups were able to confirm answers to the teacher or other group members. All groups were also able to read, write, give ideas, and carry out each step on the student worksheet, except group 1. There were only two groups that were able to speak according to the context of the material and speak politely to friends, namely groups 5 and 6. All groups have not been able to present in front of the class, and answer questions from other groups. Then, all groups were able to discuss before writing the answers to the student worksheet or before answering questions from other groups. Therefore, the results show that there are three groups that get the highest score, namely 80 which shows a high category by groups 2, 3, and 6, two other groups show a medium category by groups 4 and 5 with a score of 70, and one other group shows a low category with a score of 60 by group 1. Furthermore, the data on the collaboration skills of each group in the third meeting is presented in Table 5.

Table 5. Data on Collaboration Skills of Each Group at the Third Meeting

Observation Criteria Code	Group					
	1	**2**	**3**	**4**	**5**	**6**
A	✓	✓	✓	✓	✓	✓
B	✓	✓	✓	✓	✓	✓
C	✓	✓	-	✓	✓	✓
D	✓	-	✓	✓	-	✓
E	-	✓	✓	-	✓	✓
F	✓	✓	✓	✓	✓	✓
G	✓	✓	✓	✓	✓	✓
H	✓	✓	✓	✓	✓	-
I	-	✓	-	-	-	✓
J	✓	✓	✓	✓	✓	✓
Value	80	90	80	80	80	90
Category	H	VH	H	H	H	VH
Total	500					
Average	83					
Category	High					

Referring to Table 5, all groups can complete the student worksheet according to the time limit set by the teacher. All groups were also able to discuss in solving problems and making decisions in their respective groups. Then, all groups also looked for learning resources from the internet to solve the problems in the student worksheet, except group 3. There were two groups that were unable to provide opportunities to speak to their friends, namely groups 2 and 5. All groups were able to respect and accommodate the opinions of all group members, except group 4. Then, all groups were able to confirm answers to the teacher or other group members. All groups were also able to read, write, give ideas, and carry out each step on the student worksheet. Furthermore, there were two groups that were able to present in front of the class, and answer questions from other groups, namely groups 2 and 6. All groups also held discussions before writing the answers to the

student worksheet or before answering questions from other groups. In line with this data, the results showed that there were two groups that showed a very high category by obtaining a score of 90, namely groups 2 and 6, and four other groups that showed a high category by obtaining a score of 80, namely groups 1, 3, 4, and 5. The average collaboration skills of students at the first, second, and third meetings were 75 which indicated a moderate category. Based on Tables 3, 4 and 5, each observation criterion is fixed and increased are fixed and some are increasing. The difference in the implementation of each indicator is presented in Figure 1.

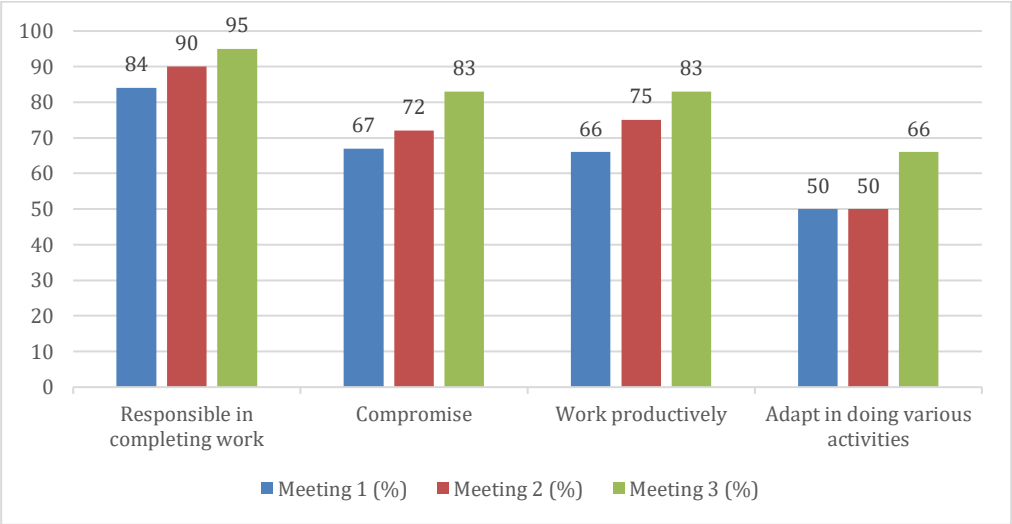

Figure 1. Data for Each Skill Indicator Collaboration

Based on Figure 1., each indicator has increased at each meeting. In the first, second, and third meetings, the indicator most implemented by students was the indicator of being responsible for completing work, namely 84%, 90%, and 95%. Then, the indicator of compromise was implemented with a percentage of 67% at the first meeting, 72% at the second meeting, and 83% at the third meeting. The indicator of working productively was implemented with a percentage of 66% in the first meeting, 75% in the second meeting, and 83% in the third meeting. Meanwhile, the indicator of adapting to various activities was implemented with a percentage of 50% in the first and second meetings, and 66% in the third meeting. This indicator is the lowest indicator implemented by students.

Based on the data from the observation of collaboration skills at the first, second and third meetings, through the implementation of the STEAM approach, students' collaboration skills have improved. The increase in collaboration skills can be seen from the observation data at the first, second and third meetings. Comparison of observation results of students' collaboration skills is presented in Figure 2.

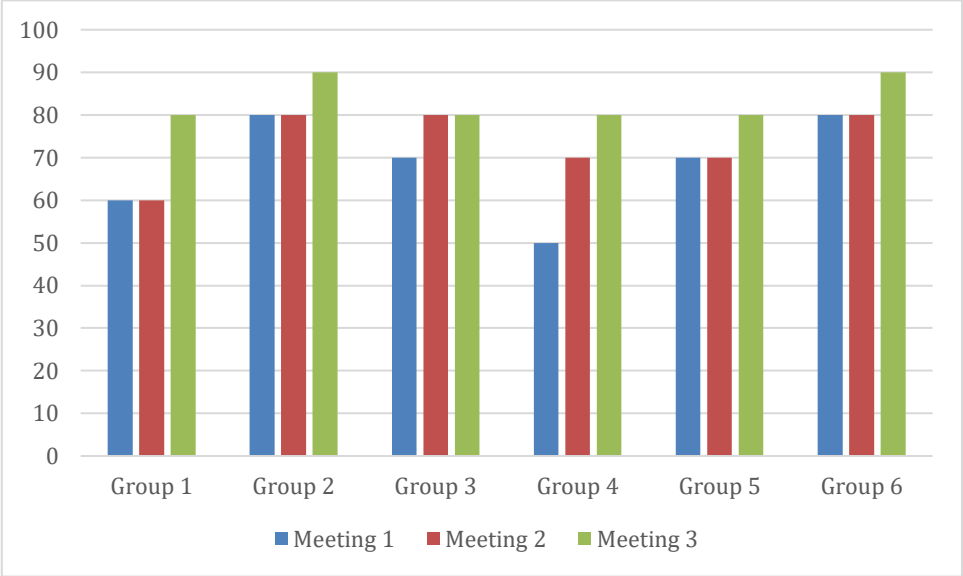

Figure 2. Comparison of Observation Data Collaboration Skills

Based on Figure 2, it shows that the collaboration skills of each group have increased. Group 1 experienced an increase from 60 in the first and second meetings to 80 in the third meeting. Group 2 increased from 80 at the first and second meetings to 90 at the third meeting. Group 3 experienced an increase from a score of 70 at the first meeting to 80 at the second and third meetings. Then, group 4 experienced an increase from a score of 50 in the first meeting, 70 in the second meeting, and to 80 in the third meeting. Group 5 improved from 70 in the first and second meetings to 80 in the third meeting. Meanwhile, group 6 increased from 80 in the first and second meetings to 90 in the third meeting.

Discussion

The indicator of being responsible for completing work is divided into three observation criteria, namely completing student worksheet according to the predetermined time limit, discussing in problem solving and making decisions in groups, and looking for learning resources from the internet to solve problems on student worksheet (Sarifah & Nurita, 2023). At the first meeting, there were two groups that did not complete the student worksheet according to the time limit set by the teacher, namely groups 1 and 5. This was due to the lack of responsibility of all group members in working on student worksheet, so that when the time for working on student worksheet was up they had not been able to finish it. Learners can find it difficult when completing tasks due to poor time management (Pertiwi, 2020). At the second meeting there were still groups that had not been able to complete the student worksheet according to the time limit given, namely group 1. The group was still not used to completing tasks on time. Then, at the third meeting all groups were able to complete the student worksheet according to the predetermined time limit. This is because students begin to be trained in doing their tasks so that they can be completed on time.

The second observation criterion, namely discussing problem solving and making decisions in groups, can be done by all groups except group 4 at the first meeting. However, in the second and third meetings all groups have been able to do problem solving and make decisions in groups. This can happen because

students have a sense of responsibility in completing the tasks on the student worksheet. The aspect of responsibility in completing work really needs to be mastered by students because by having a sense of responsibility, students will be able to complete and assess the tasks given to them (Dewi et al., 2019). Learners use all their time to conduct discussions related to the problems contained in the student worksheet.

The third observation criterion, namely students looking for learning resources from the internet to solve problems in student worksheet. At the first meeting, all groups were able to find learning resources from the internet to solve the problems in the student worksheet. However, at the second and third meetings there were groups that did not look for learning resources from the internet to solve problems on the student worksheet, namely group 2 and group 3, respectively. This caused students to ask other groups and not look for sources from the internet to solve problems on the student worksheet. Learners tend to be lazy in looking for learning resources and prefer to see answers from other groups because they think it is faster to finish without having to understand first. Learners who seek learning resources or explore information independently are one of the criteria for active learners in learning (Oishi, 2020). The STEAM approach is an approach that can guiding and directing students to always responsible for every job assigned both individually and in groups. When learning takes place, each student carries out the same obligations his group.

The second indicator is compromising which has three observation criteria, namely providing opportunities to speak to others, respecting and accommodating the opinions of all group members, and confirming answers to the teacher or other group members. The observation criteria, namely providing opportunities to speak to others at the first meeting, can be done by all groups, except groups 2 and 4. At the second meeting there were also students who had not been able to provide opportunities to speak to others, namely groups 3, 4, and 5. At the third meeting there were still groups that had not been able to provide opportunities to speak to others, namely groups 2 and 5. This can happen because students who have not been able to give each other the opportunity to speak to their group mates, thus causing group learning activities to be less successful (Hasanah & Himami, 2021). Then, the observation criteria for respecting and accommodating the opinions of all group members at the first meeting were carried out by groups 2 and 6. At the second meeting, only groups 1 and 4 had not implemented the criteria for respecting and accommodating the opinions of all group members. The third meeting all groups have done the criteria of respecting and accommodating the opinions of all group members, except for group 4. The existence of a lack of respect for the opinions of their group members when conducting discussion activities is considered to be a factor in students not doing these criteria (Fauziah & Sudibyo, 2023). Furthermore, the criteria for confirming answers to the teacher or other group members have been implemented by all groups in the first, second and third meetings. Compromise needs to be mastered by students to make it easier for them to solve problems with their friends (Cardona, 2021). Student activities through the STEAM approach can teach students to work with all group members. Students must compromise with their team in solving problems in the student work sheet regarding project work on environmental pollution problems. In solving these

problems, students compromise by being neutral in the team, respecting other people's opinions and helping group members' difficulties. The more often students help their group members' difficulties in solving problems, the more skilled the students will be in collaborating with their friends.

The fourth indicator is working productively which is divided into two observation criteria, namely reading, writing, giving ideas, and carrying out each step on the student worksheet as well as speaking according to the context of the material and speaking politely to friends. In the first and third meetings all groups could read, write, give ideas, and carry out each step on the student worksheet. Whereas in the second meeting there were groups that could not read, write, give ideas, and carry out each step on the student worksheet, namely group 2, because the group did not realize and remind each other of the agreement that had been reached previously so they did not bring the needs of their group. Whereas this collaboration skill can be improved by exchanging knowledge or ideas in order to produce creative solutions in solving a problem. Then, the criteria for speaking according to the context of the material and speaking politely to friends at the first meeting were only carried out by groups 2 and 5, at the second meeting all groups performed these criteria except groups 5 and 6, and at the third meeting all groups could also perform these criteria except groups 1 and 6. This can happen because there are group members who talk about other things outside the context of the material, so an evaluation is needed so that students can work productively when in groups. By sharing information and ideas in finding alternative solutions to problem solving can improve students' collaboration skills (Mulyani & Fuadi, 2020). Interaction between group members plays an important role in the problem solving process because one of the conditions for achieving success in solving a problem is effective interaction between group members (Harilama et al., 2020).

The indicator of adapting in carrying out various activities has two observation criteria, namely being able to make presentations in front of the class and answering questions from other groups and discussing before writing answers to student worksheet or before answering questions from other groups. In the criteria of being able to present in front of the class, and answer questions from other groups, all groups have not been able to present in front of the class, and answer questions from other groups in the first and second meetings. Meanwhile, at the third meeting only two groups could do these criteria, namely groups 2 and 6. This is because not all students are involved when carrying out student worksheet work activities. Then, on the criteria for discussing before writing answers to student worksheet or before answering questions from other groups at the first, second, and third meetings, all groups can carry out these criteria. This is because students can adapt to carrying out group discussion activities in working on the student worksheet given by the teacher. Discussion activities will be effective if there is two-way interaction (Lubis & Gusman, 2022). Effective discussion activities can occur if there is mutual interaction back and forth between the presentation group and the audience. Teachers need to accompany students during discussion activities so that learning can be carried out effectively and efficiently. The need for assistance during learning activities is in line with Vygotsky's social constructivism theory which states that students who work with peers and mentoring experts are considered to have a deeper understanding. Even though this indicator has the lowest percentage, this indicator still experiences a gradual increase at each meeting.

Through group learning activities, students can strengthen their collaboration abilities, which will enable them to respect one another, help one another solve difficulties, and participate more actively in class activities. Possessing collaboration abilities can motivate pupils to actively participate in reaching shared learning objectives. Students that work together will positively depend on one another to solve both academic and non-academic challenges. Pupils that have strong teamwork abilities will grasp concepts and solve difficulties more quickly and readily.

The group that got the lowest score in the first meeting was group 4, in the second meeting was group 1, and in the third meeting were groups 1, 3, 4, and 5. This is because students have not been able to work in groups, do not conduct discussions, are busy alone, and lack a sense of responsibility. Low collaboration skills can be caused because students find it difficult to find answers, are not willing to accept criticism from other students, and lack of student involvement during the learning process (Firman et al., 2023). Then, the groups that got the highest scores at the first meeting were groups 2 and 6, at the second meeting were groups 2, 3, and 6, and at the third meeting were groups 2 and 6. This is because students actively seek and find their own material, support each other, and actively cooperate in completing the tasks given by the teacher. High collaboration skills can help learners understand concepts and handle difficulties more quickly and be able and develop good dependence to solve problems (Sarifah & Nurita, 2023). Collaboration skills help learners interact and engage in meaningful learning. Involvement in the learning process and discussion can encourage good teamwork.

The indicator of collaboration skills that has the highest percentage is being responsible for completing work, which is shown through learners being trustworthy in completing tasks on time, fully participating in group activities, and looking for sources of information to overcome difficulties in working on student worksheet. This is important because the STEAM approach makes learners responsible for their individual and group work (Luamba & Tandapai, 2022). Every learner when in a group has a responsibility for the learning process. Meanwhile, the indicator of collaboration skills with the lowest percentage is adapting in carrying out various activities, meaning that some students have not been able to blend in doing activities with their group friends.

Implementation of the STEAM approach has a positive influence on students' collaboration skills, specifically in science lessons. This is in line with research conducted by (Ahwan & Basuki, 2023) that the STEAM approach can hone students' collaboration skills because there is a process of collaboration and direct communication with other people, so that learning goals can be achieved. The STEAM approach facilitates students to work together and be active in project activities in solving problems related to the material studied. This is supported by the opinion expressed by Nurfajariyah & Kusumawati (2023) that students who learn using the STEAM approach are actively involved in exploration activities, experiments and collaborative projects, so that students can develop critical thinking skills, creativity and collaboration. Through the STEAM approach, it can facilitate students to develop collaboration skills because in its application students are required to work together and compromise in solving problems in order to be able to find answers to the problems in question. Learning activities using the

STEAM approach will motivate students to be enthusiastic, more active, careful and responsive in problem solving activities. The STEAM approach provides students with the opportunity to collaborate with their group friends in solving problems given by the teacher through group discussions by sharing knowledge, exchanging ideas and concepts. Collaboration skills can help students socialize with friends in meaningful learning. Students actively participate in project activities, discussions and work to improve collaboration skills and create positive interdependence with each other.

Collaboration skills can be trained in science learning through the implementation of the STEAM approach as evidenced by the acquisition of the average value of students' collaboration skills at the first meeting, namely 68 which shows a low category, the second meeting is 73 which shows a medium category, and the third meeting is 83 with a high category. This can happen because researchers apply the STEAM approach which can facilitate students in collaborating and provide opportunities to help each other in completing tasks. The improvement of students' collaboration skills occurs when students carry out discussion activities with each group in carrying out project tasks in the student worksheet. The results of this study are in line with research showing that using the STEAM model can improve students' collaboration and creativity skills (Mansur et al., 2022) and also research showing the results that students' collaboration skills develop in the high category (Indrawan et al., 2021). Limitations of this study include limited sample size and short study duration. Future studies should include larger samples and longer observation periods.

4. Conclusions

Based on the results of the research and discussion that has been described, it can be concluded that the collaboration skills of students by applying the STEAM approach show high results, with most groups having a high percentage on each indicator. However, there are differences in the level of collaboration skills between one group and another. This can occur because it is influenced by several factors, such as the learning environment, interaction between students, and the learning approach applied.

Therefore, to train students' collaboration skills in the 21st century, the STEAM approach can be applied in science learning, especially on environmental pollution material. This study also has limitations from the limited number of samples and the short duration of the study, so that future studies should use a larger sample and a longer observation period.

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