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Students' Development of Collaboration and Communication Skills in Science Classrooms Using Socio-Scientific Issues

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Abstract

Today's students must excel in collaboration and communication to succeed, particularly in science education. Preliminary observations revealed that Acehnese students exhibited poor teamwork and communication skills. Socio-scientific issues can enhance these competencies when integrated into science teaching. This study used the "Tarek Pukat" activity—a traditional Acehnese fishing method—as a discussion topic related to the concept of speed in physics. Communication skills were assessed based on students' ability to articulate opinions, adjust language and tone, respond positively to others, and present ideas clearly and persuasively. Collaboration skills included research and information sharing, problem-solving, active listening, quality work, group compromise, mutual respect, shared accountability, time management, and preparedness. The study observed 278 ninth-grade students in Aceh using a quantitative descriptive approach and observation sheets as instruments. The findings indicated that integrating socio-scientific issues positively influenced students' communication and collaboration skills. These skills were categorized in the medium range, with average scores of 3.34 and 3.48, respectively, on a 5-point scale. This research highlights the potential of socio-scientific issues, such as the culturally relevant "Tarek Pukat" activity, in improving essential skills for science education and underscores the importance of integrating local context into learning.

Introduction

The changes that occurred in the era of the Industrial Revolution 5.0 in the 21st century present their own challenges to the world of education. Changes occur in the fields of economic development, environment, ecosystem, and politics. This condition requires students to learn to communicate, and collaborate in solving global problems (Malik et al., 2021). Students are required to be able to compete in facing drastic and dynamic changes. The Industrial Revolution 5.0 had a significant impact on the world of education. The transformation that occurs means that the world of education must be able to adapt to every change. This can be done through various means such as transforming learning models, providing wider access to education, more personalized and adaptive learning approaches, and developing future skills.

Developing students' future knowledge and skills is needed to produce quality human resources. The development

of 4C skills (critical thinking, creative thinking, communication, and collaboration) in the 21st century has become a benchmark as a basic skill that students must have. In this era, science education learning has a role in realizing a global vision to encourage the achievement of 21st-century competencies (Fadilah et al., 2022). Science learning emphasizes the importance of mastering critical thinking, creative thinking, communication, and collaboration skills (López et al., 2024; Lutfiah & Suharti, 2021; Thornhill-Miller et al., 2023). Communication and collaboration skills have not received much attention in the learning environment. In the era of globalization, students are required to be able to convey ideas to society (Malik & Ubaidillah, 2021). Communication is a key factor that connects communities together (Palos & Petrovici, 2014). Communication skills are the skills of expressing new ideas, thoughts, knowledge, or information in written and oral form (Supena et al., 2021). Communication skills are the qualities needed to achieve goals which include personal and interpersonal qualities as well as social abilities (Al-Alawneh et al., 2019). Communication is needed to fill human needs through exchanging thoughts and emotions with each other (Komba, 2015). There are various aspects of professional life that require communication skills. Communication skills are needed to achieve success in a profession or business globally (Ganmote, 2019). The rapid growth of the business economy requires effective communication skills with people of different cultures and languages to synchronize all business processes so that they run well. Another skill that is important to master in the 21st century in improving an individual's professional and career is collaboration (Aini & Narulita, 2020; Kolm et al., 2022).

Collaboration skills are a person's ability to work effectively and responsibly in making commitments to achieve goals (Hidayati, 2019). Collaboration skills are needed by students in social life because all behaviors and circumstances require cooperation between communities. Collaborative skills are important for students' academic and career success (Saputri & Aminatun, 2020)(Marra, Rose M Steege, Linsey Tsai, Chia-Lin Tang, 2016). Collaboration and communication skills can be implemented in the learning process through solving case studies given by the teacher at the beginning of learning (Saputra et al., 2019)(Le et al., 2018). The case studies provided relate to socio-scientific issues. Socio-scientific issue-based learning (SSI) is a learning approach method that examines social problems in learning topics (Aznam & Irwanto, 2021). The application of SSI socio-scientific issues is needed in science learning. The implementation of socio-scientific issues helps students explore important issues related to understanding scientific concepts (Morris, 2014). SSI also helps students study science and what factors influence their abilities so that students have a holistic and complete educational philosophy (Saad et al., 2017).

Socio-scientific issues (SSI) can be used as an effective pedagogical tool to improve students' communication skills by increasing peer interactions, stimulating students' reasoning, and building shared social knowledge (Chung et al., 2016). SSI has an influence in raising students' awareness of responsibility to the environment, sustainable development, environmental-related activities, and self-efficacy regarding environmental issues (Wang et al., 2018). A high level of self-efficacy will influence students' understanding of science concepts or scientific literacy (Mellyzar et al., 2022; Novita et al., 2023). Socio-scientific issue-based learning can encourage scientific reasoning about science in the classroom (Khajornkhae & Nuangchalerm, 2021). The use of socio-scientific issues in science learning has a significant effect on students' higher-order thinking abilities and scientific literacy (Zulyusri et al., 2022). Scientific literacy is an individual's ability to understand scientific

concepts so that they are capable of analyzing, reasoning, communicating effectively, and being able to solve and interpret problems (Muliani et al., 2021)(Marhami et al., 2022). The results of the researcher's initial observations show that the communication and collaboration skills of students in Aceh are still lacking. Socio-scientific issues can be used as a tool to improve student's communication and collaboration skills in science learning.

The application of socio-scientific issues is needed in classroom learning to develop students' communication and collaboration skills. Communication and collaboration skills need to be studied further. Communication problems can occur due to a lack of collaborative skills so that they influence or hinder work results (Popov et al., 2012). Indicators of communication skills include: expressing opinions; regulating word choice, volume, and voice intonation, providing a positive response to the interlocutor; conveying ideas and discussion results clearly, effectively, systematically, and convincingly; respecting other people's opinions; and answering questions. Indicators of collaboration skills include research and information sharing; problem solving and feedback; listening, asking questions, and discussing; quality of work; working productively; compromise with the group; respect opinions; shared responsibility; time management; and readiness.

Method

This research was carried out in three regencies/cities in Aceh Province, namely North Aceh Regency, Lhokseumawe City, and Langsa City. The total sample was 278 grade 9 students in 5 schools, including SMPN 1 Langsa, SMPN 3 Langsa, SMPN 1 Lhokseumawe, SMPN Arun, and SMPN 1 Dewantara in the odd semester of the 2023/2024 academic year. This type of research is quantitative descriptive in order to provide a description of junior high school students' communication and collaboration skills in science learning through socio-scientific issues. The sampling technique uses *purposive sampling* in choosing classes by paying attention to the heterogeneous abilities of students in one class and the considerations of the science teacher. The instrument in this research was an observation sheet on students' communication and collaboration skills used for data collection. This sheet is filled in by providing a *checklist,* There are 6 indicators in the observed indicators which are translated into 12 descriptors and collaboration skills consist of 10 indicators which are translated into 14 descriptors which are filled in by the observer.

In this research, a problem is given for discussion in the form of the "Tarek Pukat" activity, which is a tradition for fishermen in Aceh Province to catch fish. This activity is related to the concept of physics, namely speed. The instrument used was a communication and collaboration questionnaire distributed in schools in Aceh Indonesia. The questionnaire was designed on a Likert scale with five options: Strongly Agree (5), Agree (4), Neutral (3), Disagree (2), and Strongly Disagree (1). Indicators of communication skills include: expressing opinions; regulating word choice, volume, and voice intonation, providing a positive response to the interlocutor; conveying ideas and discussion results clearly, effectively, systematically, and convincingly; respecting other people's opinions; and answering questions. Indicators of collaboration skills include research and information sharing; problem solving and feedback; listening, asking questions, and discussing; quality of work; working productively; compromise with the group; respect opinions; shared responsibility; time management; and readiness. The data obtained was then used to analyze the level of communication and collaboration skills of students. In analyzing

communication and collaboration skills scores, conversion and categorization techniques are used. Data analysis was divided into five categories: very low, low, medium, high, and very high.

Table 1. Description of the Research Sample

Schools	Number of students
SMPN 3 Langsa	60
SMPN 1 Langsa	57
SMPN 1 Lhokseumawe	59
SMPN Arun	52
SMPN 1 Dewantara	50

The data results from the student collaboration and communication skills observation sheet are summarized using a benchmark assessment. Values are obtained from the results of the recap of the student collaboration and communication skills observation sheet and then the values obtained are categorized. Collaboration and communication skills criteria are based on benchmark assessments as in Table 2.

Table 2. Skills Criteria Student Collaboration and Communication

Value	Category
$4.69 < X$	Very high
$3.88 < X \leq 4.69$	High
$3.07 < X \leq 3.88$	Medium
$2.26 < X \leq 3.07$	Low
$X \leq 2{,}26$	Very low

Results

Communicating effectively includes articulating thoughts and ideas effectively using oral, written, and nonverbal communication skills in a number of forms and contexts (Denniston et al., 2017; Mata et al., 2021); listening effectively to understand meaning (Kwame & Petrucka, 2021; Sharkiya, 2023); using communication for a number of purposes (Dávalos-Mogollón et al., 2023); using a variety of media and technologies (Mahdi, 2023; Nkomo et al., 2021), and assessing their impact; communicate effectively in different environments. Collaborating with others includes being able to work effectively and respecting different team members; demonstrating flexibility and a willingness to be useful in making compromises to achieve common goals; assuming responsibility in collaborative work and appreciating the contribution of each team member (Redhana, 2019).

This research uses several indicators to measure student communication, including the ability to express opinions; regulate word choice, volume, and voice intonation; give positive responses to the interlocutor; convey ideas and discussion results effectively, systematically, and convincingly; respect other people's opinions; and answer questions (Ahmadi et al., 2023; Mattanah et al., 2024). Meanwhile, for collaboration skills, the indicators used are research and sharing information; problem solving and feedback; listening, asking, and discussing; quality of

work; working productively; compromise with group members; respect opinions; shared responsibility, all members contribute and provide guidance; time management; and readiness (Kusumarti et al., 2024; Marmoah et al., 2022; Mena-Guacas et al., 2023). Based on the results of observational assessments of communication and collaboration skills of junior high school students in Aceh, data obtained on each indicator of communication and collaboration skills among students is presented in Figures 1 and 2.

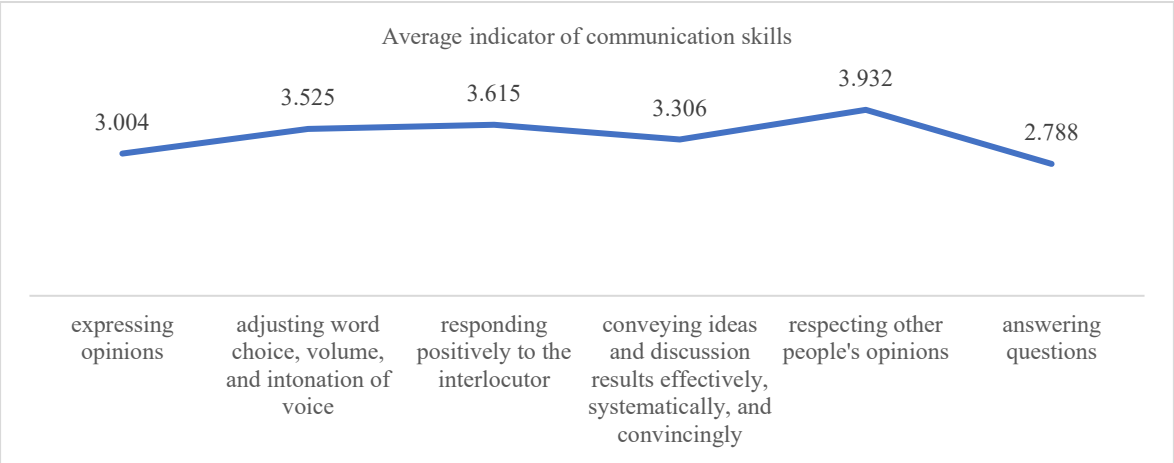

Figure 1. Average Indicator of Communication Skills

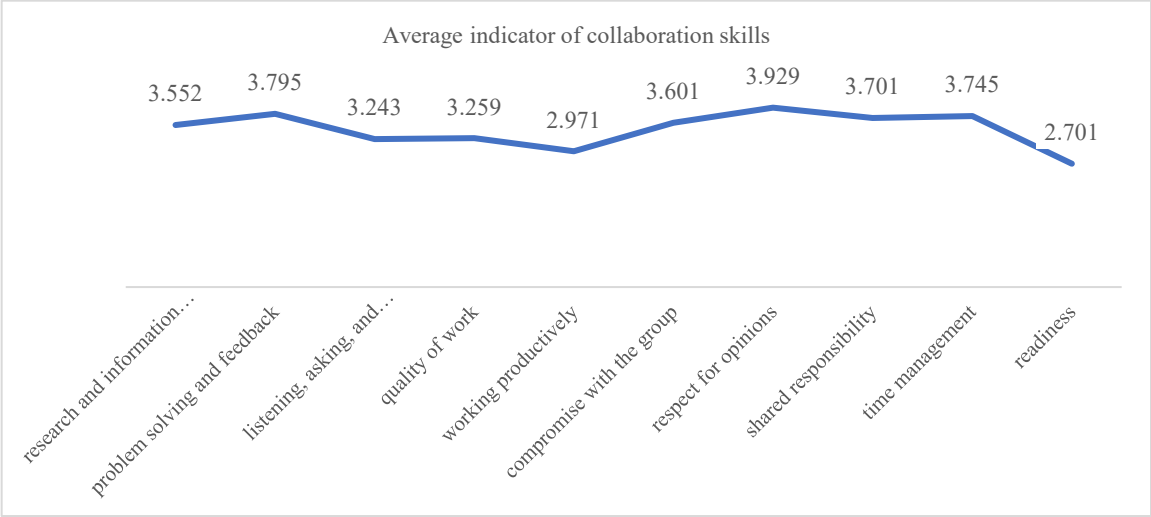

Figure 2. Average Indicator of Collaboration Skills

Effective communication is essential for students to express their ideas clearly and engage in meaningful discussions, while collaboration skills are crucial for working successfully in teams. The findings indicate that junior high school students in Aceh exhibit varying levels of proficiency in these skills, highlighting the need for targeted educational interventions to enhance their abilities (Harackiewicz & Priniski, 2018; Ishida & Sekiyama, 2024). Figures 1 and 2 illustrate the data collected from observational assessments, providing insights into the strengths and weaknesses of students' communication and collaboration skills. These results underscore the importance of fostering an environment that encourages active participation and constructive feedback among students to improve their overall competencies in these areas.

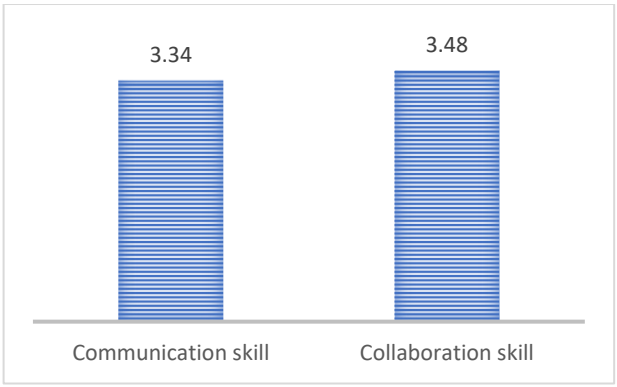

Figure 3. Average Communication and Collaboration Skills

The average communication skill score of 3.34 and collaboration skill score of 3.48 indicate a moderate level of proficiency among junior high school students in Aceh. This suggests that while students possess some foundational skills in these areas, there is significant potential for improvement through targeted educational strategies and interventions that foster greater engagement and practice in both communication and collaboration.

Discussion

Communication Skills

Communication skills are students' ability to present what they have learned, either in writing or orally. Communication in the learning process, apart from conveying material, is also aimed at building relationships between teachers and students, students and teachers, or students and students (Chung et al., 2016; Hastuti & Hidayati, 2018; Wilczewski & Alon, 2023). This research shows that the communication skills of 278 students in Aceh are in the "medium" category, from data with an assessment score of 3.34. This is a portrait of the communication skills of junior high school students in Indonesia. In line with research (Astuti & Pratama, 2020) the communication skills of 124 students in Yogyakarta are in the medium category, appropriate interventions need to be given so that students' communication skills can improve with adequate self-efficacy. Communication in learning will make learning activities more effective because communication is built between teachers and students, or between fellow students so that learning objectives can be achieved (Marfuah, 2017). The moderate average communication skill score of 3.34 suggests that while students have a basic ability to communicate, there is room for growth. Enhancing these skills through focused educational practices can lead to more effective learning environments and better student outcomes (Ishida & Sekiyama, 2024).

The description based on Figure 1 relates to data from observations of student communication indicators. The indicator of respect for other people's opinions is in the "high" category with a score of 3.932, meaning Partial Most students always listen to other people's opinions well, if there is a difference in the teacher's opinion provide opportunities for other students to express their opinions, and the teacher's job is to clarify suggestions or opinion which then provides a conclusion. Students who respect other people's opinions create more effective learning and no disputes (Zulfa et al., 2020). The group discussion method can form students' emotions to be able to respect other people's opinions (Bjørke & Moen, 2020) (Bjørke & Moen, 2020) getting students used to hearing other people's opinions, even if they are different from themselves, is a way to get students used to it and be tolerant

(Djamarah, 2015).

The ability to express students' opinions with a score of 3.004 in the "medium" category. This research uses three statements consisting of one positive statement, namely the student's ability to convey ideas or questions clearly and easily understood, research results for the first statement with a score of 3.68 in the "medium" category. The second and third statements are positive statements. The second statement is that students' communication skills are limited only to verbal explanations of the second statement with a score of 2.68 in the "low" category and the third statement, namely the student's ability to provide less explanation of discussion results in various contexts with a score of 2.70 in the "low" category. The ability to express opinions needs to be improved by getting used to learning that requires students to carry out communication. Communication skills are skills that students need to speak, listen, solve problems, verbal and non-verbal communication, and solve problems constructively (Wilhalminah et al., 2017). Indicators regulate word choice, volume, and voice intonation with a score of 3,525 and "medium" criteria. The statement for this indicator is that students can provide an explanation of the results of discussion related to the topic discussed effectively using oral including accuracy of delivery, sound volume, and proper articulation. The indicator provides a positive response to the interlocutor, a score for this indicator is 3.615 in the "medium" category.

Indicators convey ideas and discussion results effectively, systematically, and convincingly obtained a score of 3.306 in the "medium" category. Conveying ideas and discussion results effectively, systematically, and convincingly is a very important skill for students, the ability to convey ideas and the results of the discussion involves effective communication skills. Students need to be able to organize their thoughts well and communicate them clearly to others. There are four statements used to assess this indicator, which consists of three positive statements and one negative statement. Positive statements include students being able to express ideas or ideas clearly and easily understandably, which received a score of 3.42 (medium). Another statement regarding students' ability to communicate using a logical and structured train of thought scored 3.61 (medium), while the statement about students communicating with good body movements or gestures received a score of 3.47 (medium). The negative statement regarding students' lack of confidence in communicating and expressing their ideas scored 2.72 in the "low" category.

Additionally, the score for the ability to answer questions indicator is 2.788, placing it in the "low" category. The ability to answer questions is crucial for students in learning groups, as it reflects their understanding of the lesson material. This skill helps teachers evaluate the extent to which students grasp key concepts. Answering questions clearly and in a structured manner is an important communication skill; students who can explain their thinking well are more likely to be noticed and understood by teachers and their peers. Research indicates that effective communication skills are vital for academic success and are closely linked to students' confidence and engagement in the learning process. According to Awidi & Klutsey (2024) and Severe et al (2024), students who feel confident in their communication abilities are more likely to participate actively in discussions and collaborative learning environments. Furthermore, Monteiro et al (2021) emphasize that the ability to articulate thoughts clearly not only enhances individual learning but also fosters a more interactive and supportive classroom atmosphere. Therefore, addressing the low confidence levels observed in this study is essential for improving overall communication

skills among students.

Collaboration Skills

Collaboration skills are very important for each individual and are developed (Alexandrou, 2020; Hermawan et al., 2017; Marlina et al., 2024). According to research that has been conducted, collaboration skills are low, especially among school children and workers (Ayu et al., 2018; D'Agostino, 2013; Haight et al., 2024). (Trilling & Fadel, 2009) stated that collaboration skills need to be paid attention to and developed. Collaboration skills are the ability to work together and have responsibility for their duties (Pheeraphan, 2013). Collaboration skills have an important role for students to develop so they can work together in groups in facing 21st-century competition (Muiz et al., 2016).

The research results related to students' communication skills can be seen in Table 2. From the research data, students' communication skills averaged 3.48 in the "medium" category. The indicator respects opinions with a score of 3.929 in the "high" category. The statement used in the first assessment students can work without conflict with other colleagues to make decisions. Second, students listen to and respect the opinions of teammates in putting forward ideas, ideas, opinions, and suggestions in teamwork. Respecting other people's opinions helps in building a positive cooperative atmosphere (Reich & Reich, 2006; Teitelbaum & Ben-Ze'ev, 2023). This creates an environment where students feel comfortable sharing their ideas, views, and knowledge. This provides an opportunity to look at an issue or topic from diverse points of view, which can enrich their understanding.

Indicators of students' initial readiness regarding ethnoscience-based literacy and numeracy are still "low" with a score of 2.701. This shows that students lack initial skills in ethnoscience-based literacy and numeracy. From the research results, this indicator can be improved by designing learning programs that focus on developing ethnoscience-based literacy and numeracy. The program must be designed to meet the needs of students taking into account their level of readiness. Teachers must have a deep understanding of how to integrate ethnoscience elements into literacy and numeracy learning. The indicator of working productively is also still classified as "low" with a score of 2.971. The statement used in assessing this indicator is the level of student understanding in group assignments. Here it can be seen that students do not understand the tasks in the group and do not know their own strengths and weaknesses. What can be done is that the teacher can provide additional detailed explanations about the group assignments. Make sure students understand the goals, steps to take, and expected outcomes.

Improving students' ethnoscience-based literacy and numeracy skills is crucial for fostering a deeper understanding of the cultural contexts of science and mathematics in their everyday lives (Ansumarwaty, 2023; Rusmansyah et al., 2023). Research has shown that incorporating ethnoscience into the curriculum enhances students' engagement and comprehension by connecting academic content with their cultural backgrounds (Sotero et al., 2020; Suprapto et al., 2024). Additionally, the low score of 2.971 for the indicator of working productively highlights a need for more structured group activities that promote collaboration and self-awareness among students. According to Chiriac (2014) and Paolini (2015), effective group work can significantly enhance student

learning outcomes by encouraging communication, accountability, and mutual support. Therefore, teachers should implement strategies that clearly define roles and responsibilities within group assignments, ensuring that students are aware of their strengths and how they can contribute to the group's success.

The research and information-sharing indicators obtained a score of 3.552 in the "medium" category. There are two statements used: one regarding students inviting their colleagues to generate ideas to solve problems, and the other about students providing references for information, ideas, suggestions, solutions, knowledge, opinions, and skills in group discussions related to the discussion topic. The "medium" category is also applicable for problem-solving and feedback indicators with a score of 3.795. The assessment statement used is that students help teammates who find it difficult to understand the problems faced in the assigned tasks. To improve these indicators, teachers can encourage students to work collaboratively on assignments. Forming pairs or small groups can facilitate peer learning, allowing students to support and learn from each other. Research has shown that collaborative learning environments enhance student engagement and achievement (Huri et al., 2024; Kumar, 2017). When students work together, they not only share knowledge but also develop essential skills such as communication, critical thinking, and teamwork (Mena-Guacas et al., 2023). By involving students in supporting their teammates, teachers can create a collaborative atmosphere that fosters the exchange of ideas and mutual assistance, ultimately enhancing the quality of group assignments. Furthermore, the ability to share information and provide constructive feedback is crucial in developing students' critical thinking and problem-solving skills. According to Lerchenfeldt et al (2019) and Er et al (2021) effective feedback and collaborative discussions can lead to deeper learning and improved academic performance. Thus, teachers should implement strategies that promote open communication and encourage students to actively participate in discussions, ensuring that all voices are heard and valued.

The findings from the assessment indicate that students exhibit a medium level of engagement in listening, asking questions, and discussing topics, with a score of 3.243. This suggests that while students are participating in discussions, there is room for improvement in their attentiveness and focus on their peers. The ability to listen actively and engage with colleagues is crucial for effective collaboration and problem-solving. As highlighted in the literature, active listening is a key component of effective communication and is essential for fostering a collaborative learning environment (Idsardi, 2020; Ribeiro-Silva et al., 2022). Moreover, the work quality indicator received a score of 3.259, reflecting a medium level of enthusiasm among students in expressing their ideas and engaging seriously in discussions. This finding aligns with research that emphasizes the importance of student engagement in the learning process. According to Fredricks et al (2004) engagement is critical for academic success and can be enhanced through interactive teaching methods. Teachers can implement strategies such as group discussions, simulations, role plays, and collaborative projects to stimulate interest and encourage participation.

The indicator of compromise with group members scored 3.601, indicating a medium level of openness to differing ideas. This is a positive sign, as it suggests that students are willing to consider various perspectives during discussions. However, to further enhance this openness, educators should create a safe and inclusive classroom environment. Encouraging open discussions and providing guidance can help students feel comfortable

sharing their opinions without fear of ridicule or judgment. Research by Kolyda (2023) emphasizes the importance of a growth mindset in fostering an environment where students feel valued and respected, which can lead to increased participation and collaboration. In conclusion, while the assessment scores indicate a medium level of engagement and openness among students, there are several strategies that educators can implement to enhance these skills. By fostering an interactive learning environment and encouraging open dialogue, teachers can help students improve their listening, discussion, and collaborative skills, ultimately leading to better problem-solving outcomes.

The assessment results indicate that the indicator of shared responsibility among group members scored 3.701, reflecting a medium level of contribution and guidance. This score suggests that while students are participating in group activities, their potential to fully engage and contribute throughout the entire discussion process has not yet been maximized. Research shows that shared responsibility is vital for effective teamwork, as it fosters accountability and enhances group dynamics (Morales-Huamán et al., 2023; Stewart et al., 2023). When students actively participate in all phases of a project, from planning to execution, they are more likely to develop essential skills such as leadership, communication, and collaboration (Kaur et al., 2023; Mutanga, 2024) The time management indicator also scored 3.745, indicating that most students are able to complete assignments on time without impeding the progress of their peers. This is a positive finding, as effective time management is crucial for collaborative work. Time management skills are significantly related to academic performance, suggesting that students who manage their time well are more likely to succeed in collaborative environments (Calonia et al., 2023; Sevari & Kandy, 2011)

However, there remains an opportunity for educators to further enhance these skills by implementing structured timelines and checkpoints throughout group projects. To improve student collaboration and maximize contributions, teachers can design projects that require teamwork and collective effort. For instance, group assignments, joint research projects, or group presentations can facilitate shared responsibility and encourage students to rely on one another's strengths. Research by Slavin et al (2003) emphasizes that cooperative learning strategies not only enhance academic achievement but also promote positive interpersonal relationships among students. By organizing work groups with diverse members, teachers can stimulate collaborative thinking and enrich the learning experience, as students bring different skills, backgrounds, and perspectives to the table (Bennett et al., 2003). In conclusion, while the scores indicate a medium level of shared responsibility and time management among students, there are several strategies that educators can employ to foster greater collaboration. By creating opportunities for teamwork and encouraging diverse group compositions, teachers can help students develop a stronger sense of accountability and improve their collaborative skills, ultimately leading to more successful group outcomes.

Conclusion

The results of the researcher's initial observations showed that the communication and collaboration skills of students in Aceh were very poor. Socio-scientific issues can be used as a tool to improve student's communication and collaboration skills in science learning. In this research, a problem was given for discussion in the form of the

"Tarek Pukat" activity, which is a tradition for fishermen in Aceh Province to catch fish. This activity is connected to the physics concept, namely speed. Indicators of communication skills include: expressing opinions; adjusting word choice, volume, and intonation of voice, responding positively to the interlocutor; conveying ideas and discussion results clearly, effectively, systematically, and convincingly; respecting other people's opinions; and answering questions. Indicators of collaboration skills include research and information sharing; problem solving and feedback; listening, asking, and discussing; quality of work; working productively; compromise with the group; respect for opinions; shared responsibility; time management; and readiness. We conducted observations on 278 grade 9 Junior High School students in Aceh Province, Indonesia. The research used a quantitative descriptive method using observation sheets as an instrument, the results showed that teaching with socio-scientific issues had a good impact on students' communication and collaboration skills in the medium category with scores of 3.34 and 3.48 respectively on a maximum scale of 5.

Recommendations

Further research is needed to examine students' creative and critical thinking abilities to complete the study of all of the competencies in the 21st century. Additionally, another research is needed to design a learning model that develops all of these competencies.

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