



Integrating SOLE–TASC to Enhance Students’ Collaborative and Communicative Competencies in Science Learning

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ABSTRACT

Collaboration and communication are essential 21st-century skills. Observations and interviews suggest that these are among students in science learning are still not fully developed. This study aims to analyze the differences in collaboration and communication skills between the experimental and control classes and examine the relationship between these two skills through implementation of the Self-Organized Learning Environment (SOLE) model, integrating thinking actively in a social context (TASC). The research employed a quantitative method with a quasi-experimental design. The study groups being a pretest–posttest control group involving two seventh-grade classes (VII G and VII H), selected through cluster random sampling. Research instruments included validation sheets, questionnaires, and observation rubrics. The data analysis techniques employed included the homogeneity test, the normality test, the independent sample t-test, and the correlation test. The findings revealed significant improvements in collaboration and communication skills in the experimental class compared to the control class ($p < .05$). Pearson correlation analysis further indicated a very strong positive relationship ($r = .854$; $p < .05$) between the two skills in the experimental class. These results suggest that integrating the SOLE-TASC is effective in enhancing students’ collaboration and communication skills in science learning compared to conventional instruction.

Keywords: Collaboration Skills, Communication Skills, SOLE, TASC

INTRODUCTION

The 21st century presents significant challenges that demand a competitive and relevant education system (Isma, 2023). In this context, learning requires not only the utilization of digital resources but also the development of essential soft skills, such as critical thinking, collaboration, communication, and creativity (Mardhiyah et al., 2021). In science learning, 21st-century skills play a crucial role because science studies natural phenomena that require in-depth reasoning (Wisudawati & Sulistyowati, 2022). The integration of these skills in science learning needs to be emphasized so that students not only master scientific knowledge but also are able to solve problems and adapt to technological and social developments (Alwanda

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et al., 2024). Among these skills, collaboration and communication are crucial aspects that help students convey ideas and knowledge clearly and effectively (Thahir, 2024).

Collaboration is a skill that students must possess to synergize, work together, appreciate differences, and adapt to responsibilities and roles (Suhardjono, 2022). In science learning, this skill is essential to support group work during discussions and practical work (Hasanah & Hasruddin, 2024). An emphasis on collaborative learning can be an important provision in honing social skills through interactions between students in the classroom (Priandini & Aristiawan, 2024). Similarly, communication skills are equally important because they enable students to convey ideas, messages, or concepts both verbally and non-verbally in order to achieve common goals (Rambe et al., 2022). In science learning, communication includes the ability to interact regarding material verbally and in writing (Tiyastuti et al., 2022), as well as transferring findings in the form of tables, charts, pictures, diagrams, or graphs that can be explained coherently. This shows that communication skills play an essential role in supporting the success of the science learning process (Sari et al., 2024).

Communication and collaboration skills are essential for everyday life, yet they remain relatively low in Indonesia (Reni et al., 2021). This finding is supported by Fajarwati et al. (2023), who explain that communication and collaboration skills are among the relatively underdeveloped skills in Indonesia. Observations and interviews at SMP Negeri 1 Mandiraja indicate that students' collaboration and communication skills still need improvement. In group work, some students have not fully fulfilled their expected roles, possibly due to varying learning motivations and less challenging learning activities. A similar issue is evident in communication skills, where students are not yet accustomed to presenting discussion results coherently and convincingly, and do not fully understand the content of the discussions presented. Limited experience practicing presentations is suspected to be a contributing factor. Variation in learning strategies also plays a crucial role, as monotonous learning and material perceived as abstract and difficult can pose challenges to developing collaboration and communication (Taher, 2023).

The implementation of learning models that not only emphasize conceptual understanding but also provide space for practicing cooperation and interaction between students is necessary (Dahlan et al., 2024). Appropriate models and approaches are believed to support the improvement of collaboration and communication skills, enabling students to participate more actively in a collaborative and interactive learning environment (Fazhari & Yuniawatika, 2025). The SOLE learning model conditions students to develop 21st-century skills, including collaboration, communication, creativity, and critical thinking skills (Fikri, 2022). The use of TASC in the learning process can provide opportunities for students to collaborate, experiment, and reflect on themselves to improve (Murwaningsih & Fauziah, 2022).

One alternative is the implementation of the Self-Organized Learning Environment (SOLE) model, which enables students to understand the material independently, utilize technological literacy, and communicate the knowledge they have acquired to others (Firdaus et al., 2021). To support its effectiveness, an approach that encourages active engagement and hands-on experience is needed, one of which is Thinking Actively in a Social Context (TASC). This approach is oriented towards critical thinking and problem-solving skills and requires students to actively participate in learning (Murwaningsih & Fauziah, 2022; Muqsith & Maulana, 2022). Ecological and biodiversity materials in science learning in junior high schools are very suitable for implementing the SOLE model integrated with TASC, as they provide opportunities for students to analyze environmental phenomena around them while practicing collaboration

and communication skills in discussions (Alifiyah et al., 2024). In the SOLE model integrated with TASC, the learning process is more focused, with students engaging in discussions using internet technology, which fosters their motivation to explore. These activities can train students' collaboration and communication skills in discussions and presentations. Based on these considerations, this study aims to analyze the differences in collaboration and communication skills between the experimental and control classes and examine the relationship between these two skills in the experimental class through the implementation of the SOLE model, integrated with the TASC model.

METHOD

Research Design

This study employed a quantitative approach with a quasi-experimental design, specifically a pretest–posttest control group design. This design involved two groups: an experimental class that received treatment with the self-organized learning environment (SOLE) model, integrating thinking actively in a social context (TASC), and a control class that followed conventional learning, as presented in Table 1. Both groups were administered pretests and posttests to compare their collaboration and communication skills and to investigate the relationship between these two skills in the experimental class.

Table 1. Research design

Group	Pretest	Treatment	Posttest
Experimental	O ₁	X	O ₂
Control	O ₃	Y	O ₄

Note:

- X = Learning using the SOLE-TASC model
- Y = Learning using the direct instruction model
- O₁ = Observation and initial questionnaire of the experimental class
- O₂ = Observation and final questionnaire of the experimental class
- O₃ = Observation and initial questionnaire of the control class
- O₄ = Observation and final questionnaire of the control class

Procedures

This research was conducted in three stages: preparation, implementation, and analysis. The preparation stage included initial observations and interviews with the problem, conducting homogeneity tests, determining the experimental and control classes, developing learning designs and instruments, and validating the instruments and testing the questionnaires used. The implementation stage involved initial observations of students' collaboration and communication skills, conducted through questionnaires and observation rubrics. This was followed by the implementation of the self-organized learning environment (SOLE) model integrated with thinking actively in a social context (TASC) in the experimental class presented in Table 2. Final observations were then conducted through questionnaires and observation rubrics to assess the students' collaboration and communication skills after receiving treatment.

Table 2. Implementation of the TASC Integrated SOLE Model

SOLE Model Syntax	TASC Stages	TASC Integrated SOLE Model Syntax
Question	Gather Identify	1. Analyze existing problems related to science learning. 2. Identify solutions to problems.
Investigation	Generate Decide Implement Evaluate	1. Conduct group discussions by sharing opinions. 2. Conduct investigations and explorations related to problems or assignments. 3. Determine the appropriate answers or solutions to the problems. 4. Record observation results and double-check the answers obtained in the LKPD as presentation material.
Review	Communicate Evaluate Learn from experience	1. Conduct a presentation based on the results of the discussion. 2. Evaluate the results of the investigation through class discussion. 3. Reflect on the learning that has taken place.

The implementation stage involved implementing learning in accordance with the learning tools in the experimental class through a self-organized learning environment model and direct instruction in the control class. The analysis stage involved analyzing the differences in the improvement of collaboration and communication skills of students in the experimental and control classes. The analysis also included analyzing the positive and significant relationship between collaboration and communication skills of students in the experimental class after the treatment was implemented.

Population and Sample

The population of this study consisted of all seventh-grade students at SMP Negeri 1 Mandiraja in the even semester of the 2024/2025 academic year. The research sample was determined using a cluster random sampling technique, following a homogeneity test conducted with the Levene test to ensure equality of variance between classes. The test results showed a significance value of $.247 > .05$, so the data were declared homogeneous. From this population, two classes were selected: class VII G, with 36 students, as the experimental group, and class VII H, with 36 students, as the control group.

Research Instruments

The research data were obtained through questionnaires and observations, which were used simultaneously as a form of cross-check, considering that affective skills such as collaboration and communication are difficult to observe with only one method. The questionnaire instrument consisted of 25 statements for each skill, while the observation sheet contained 5 items for collaboration and 4 items for communication, all using a 4-point Likert scale. The questionnaire and observation rubric assessed five collaboration indicators: actively contributing, demonstrating flexibility, working productively, showing responsibility, and

exhibiting respect (Greenstein, 2012). Communication skills indicators included presenting material clearly, mastering the material presented, answering questions effectively, and demonstrating respect (Mardikawati & Mundilarto, 2020).

Content validation conducted by three science lecturers and two science teachers revealed that all questionnaire items were deemed valid. The observation sheet contained 15 valid items for collaboration and 12 valid items for communication. Reliability testing, as measured by Cronbach's Alpha, also demonstrated that the instrument was reliable, with values of .820 for the collaboration questionnaire and .793 for the communication questionnaire, respectively. Before the treatment, students from both the experimental and control classes participated in observations and completed an initial questionnaire to assess their skills. Next, learning with the SOLE model, integrated with the TASC model, was applied to the experimental class, while the control class used direct instruction. After six meetings, observations, and a final questionnaire were conducted to measure post-treatment collaboration and communication skills.

Data Analysis Techniques

Data analysis in this study was conducted using SPSS. A Shapiro–Wilk normality test was performed first as a prerequisite for the analysis. Next, an independent sample t-test was used to determine whether there was a significant difference in collaboration and communication skills between the experimental and control classes. The mean difference was calculated to determine the effectiveness of the learning model in training students' collaboration and communication skills. Furthermore, a product-moment correlation test using SPSS was used to identify a positive and significant relationship between collaboration and communication skills in the experimental class.

RESULTS AND DISCUSSION

Results

The data obtained from this study comprise the initial and final scores of students' collaboration and communication skills, as assessed through observation activities conducted by three observers and questionnaires completed by the students. The initial and final score data obtained were used to analyze the application of the self-organized learning environment (SOLE) model, integrated with the thinking actively in a social context (TASC), to collaboration and communication skills using normality tests, independent t-tests, and correlation tests. The student observation and questionnaire scores obtained include data on student collaboration and communication skill indicators, which are used to analyze improvements in each indicator by calculating the scores obtained by students. Student collaboration and communication skill scores were tested for normality before data analysis. The results of the normality test are presented in Table 3.

Table 3. Normality Test Results

Group	Collaboration Skills		Communication Skills	
	Initial Score (Sig.)	Final Score (Sig.)	Initial Score (Sig.)	Final Score (Sig.)
Experimental	.110	.104	.296	.385
Control	.186	.159	.074	.272

The normality test shows that the initial and final scores for collaboration and communication skills are normally distributed, indicated by H_0 being accepted and H_1 being rejected if the significance value is $>.05$. This means that the students' collaboration and communication skills score data can be tested using parametric statistics, including the independent sample t-test and the product-moment correlation test.

Differences in the Improvement of Students' Collaboration Skills in the Experimental Class and the Control Class

Collaboration skill indicators in this study include active contribution, flexibility, work productivity, responsibility, and respect for others (Greenstein, 2012). These skills were evident during student discussions while working on the Student Activity Sheet on ecology and environmental conservation. This is in line with Muamala & Wulandari (2024), who explained that in science learning, collaboration skills can be observed through group activities, such as discussions and providing positive feedback. The initial collaborative skills score was used to assess students' baseline skills before the treatment, specifically the implementation of the TASC-integrated SOLE model in the experimental class and the direct instruction model in the control class. The final score was used to determine the students' final condition after the treatment. The results of the study, which obtained the difference in mean collaborative skills scores in the experimental and control classes, are presented in Figure 1.

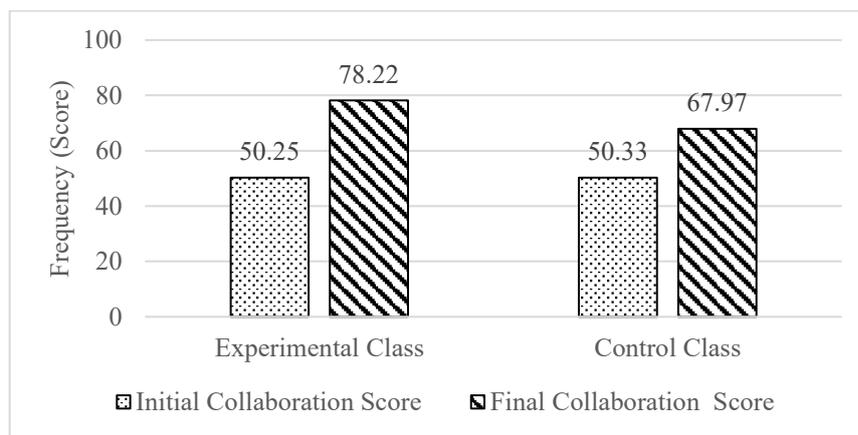


Figure 1. Difference Mean Collaboration Scores between the Experimental and Control Classes

The initial assessment results showed an average collaboration skill of 50.25 in the experimental class and 50.33 in the control class. After treatment, the final average score increased to 78.22 in the experimental class and 67.97 in the control class. Thus, the difference in improvement between the experimental class and the control class reached 27.97, while in the control class it was 17.64. This difference in improvement was then tested using an independent sample t-test to determine its significance. The analysis results showed a significant difference between the two classes, as shown in Table 4.

Table 4. Results of the Independent Sample t-Test

<i>Mean Difference</i>	<i>t</i>	<i>Std. Error Difference</i>	<i>Sig (2-tailed)</i>
10.33	6.589	1.568	.000

The results of the independent sample t-test in Table 2 show a significance value (2-tailed) of .000. Because this value is $<.05$, H_1 is accepted and H_0 is rejected, which means there is a significant difference in the initial-final value of students' collaboration skills between the experimental class with the application of the self-organized learning environment (SOLE) model integrated with thinking actively in a social context (TASC) model and the control class with the direct instruction model. All aspects of the collaboration indicators also show a higher percentage of improvement in the experimental class compared to the control class, as presented in Figure 2.

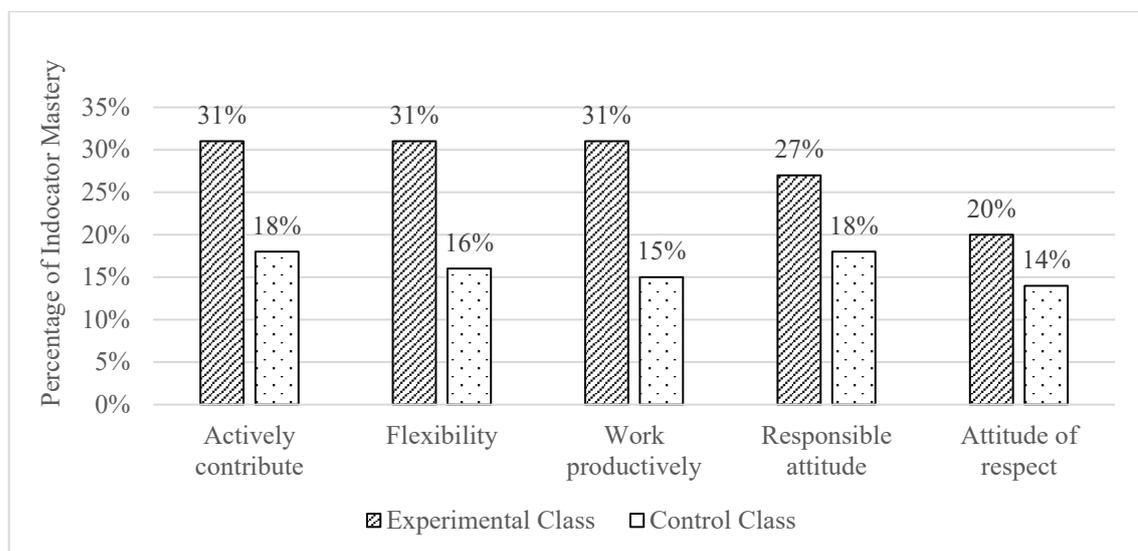


Figure 2. Percentage of Increase in Collaboration Indicators for Experimental and Control Classes

Figure 2 illustrates that the percentage improvement in all aspects of the collaboration indicators in the experimental class exceeded that in the control class. The differences in percentage improvement for each indicator of student collaboration skills between the experimental and control classes were 13% for actively contributing, 15% for flexibility, 16% for working productively, 9% for a responsible attitude, and 6% for an attitude of respect. The indicator with the highest difference in collaborative skills improvement was working productively. The results obtained demonstrate that the implementation of the TASC-integrated SOLE model is more effective in training students' collaboration skills in ecology and environmental conservation topics compared to the direct instruction model.

Differences in the Improvement of Students' Communication Skills in the Experimental Class and the Control Class

Communication skill indicators include the ability to present material clearly, master the subject matter, answer questions effectively, and demonstrate respect (Mardikawati & Mundilarto, 2020). In this study, communication skills were evident when students presented the results of class discussions on ecology and environmental conservation to the class. They

explained their understanding of the discussion and then actively answered questions from the teacher and their peers. This aligns with Muamala & Wulandari (2024), who emphasized that oral communication skills in science learning can be observed through the presentations of discussion results in class. Initial communication skill scores were used to assess the participants' communication skills before the treatment, while final communication skill scores were used to evaluate the students' condition after the treatment. The results of the study, which showed the difference in mean communication skills scores in the experimental and control classes, are presented in Figure 3.

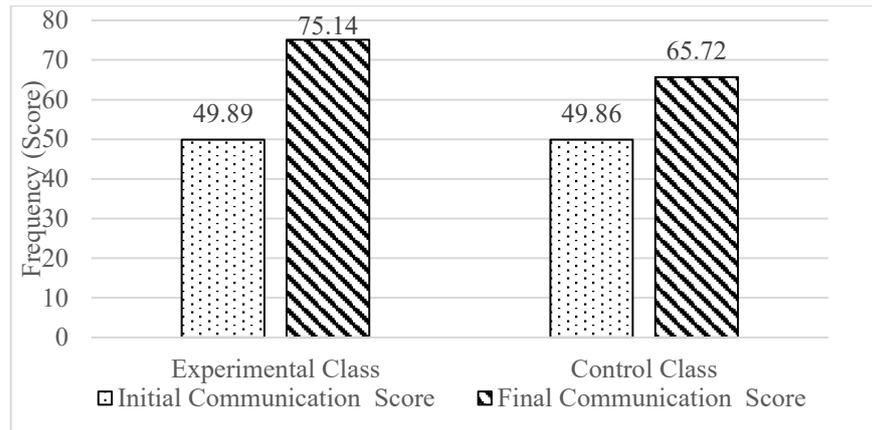


Figure 3. Difference Mean Communication Scores between the Experimental and Control Classes

The results showed an average initial communication skill score of 49.89 for the experimental class and 49.86 for the control class, indicating that both were still not optimal. After implementing the self-organized learning environment (SOLE) model, integrated with thinking actively in a social context (TASC), in the experimental class and the direct instruction class, the final average increased to 75.14 for the experimental class and 65.72 for the control class. The difference in improvement in the experimental class reached 25,25, higher than the control class at 15,86. The independent sample t-test presented in Table 5 confirms that the difference in communication skill improvement between the two classes is significant.

Table 5. Results of the Independent Sample t-Test for Communication Skills

Mean Difference	Std. Error Difference	t	Sig (2-tailed)
9.389	1.678	5.594	.000

The results of the Independent Sample t-test showed a significance value (2-tailed) of .000 ($< .05$), indicating that H_1 was accepted and H_0 was rejected. Thus, there was a significant difference in the initial and final communication skill scores between the experimental class, which utilized the self-organized learning environment (SOLE) model integrated with thinking actively in a social context (TASC), and the control class with the direct instruction model. To clarify these results, Figure 4 presents the percentage increase in each communication skill indicator.

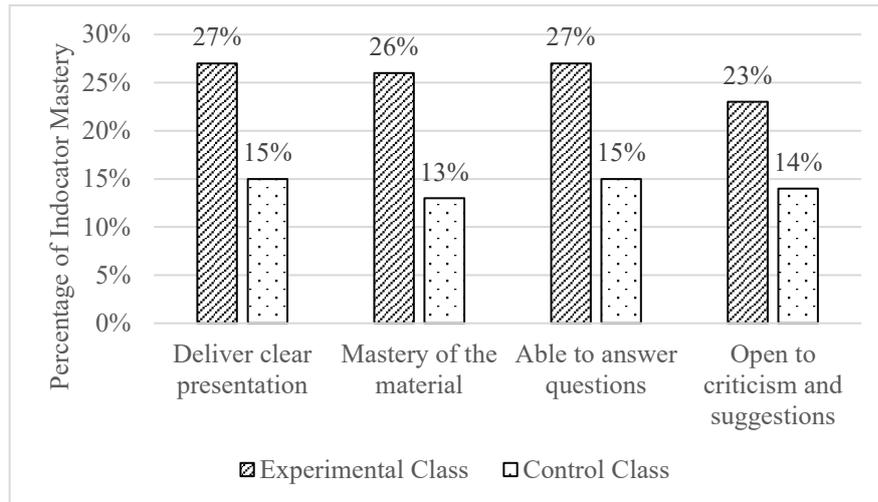


Figure 4. Percentage of Improvement in Communication Indicators in the Experimental Class and Control Class

Figure 4 shows that the percentage increase in communication skills indicators in the experimental class was higher than in the control class across all indicators. The differences in the percentage increase in communication skills indicators in the experimental and control classes were, respectively, the indicator of delivering a clear presentation 12%, the indicator of mastery of the material presented 13%, the indicator of being able to answer questions 12%, and the indicator of being open to criticism and suggestions, 9%. The indicator with the highest difference in communication skills improvement was the indicator of mastering the material presented. The research results demonstrate that the implementation of the TASC-integrated SOLE model can effectively train students' communication skills in ecology and environmental conservation topics compared to the direct instruction model in the control class.

The Relationship between Collaboration Skills and Communication Skills after the Implementation of the SOLE-TASC Model

The final score data of collaboration and communication skills were analyzed using the Pearson Product-Moment correlation test to determine the existence of a significant positive relationship in the experimental class after the implementation of the self-organized learning environment (SOLE) model integrated with thinking actively in a social context (TASC). The test results showed a significance value (2-tailed) of .000 and a correlation coefficient of 0.854, which falls within the range of .80–1.00, indicating that H1 is accepted and H0 is rejected, as presented in Table 6. These findings suggest that students' collaboration and communication skills have a strong and unidirectional relationship, indicating that increased collaboration is closely correlated with enhanced communication.

Table 6. Correlation Test Results

Data	Communication	
Collaboration	Pearson Correlation	.854
	Sig. (2-tailed)	.000
	N	36

Discussion

Differences in the Improvement of Students' Collaboration Skills in the Experimental Class and the Control Class

Collaboration and communication skills in science learning are essential for students because they not only learn scientific concepts but also the process of discovering and understanding knowledge (Hasanah & Hasruddin, 2024). According to Muamala & Wulandari (2024), students' collaboration skills are essential in science learning, particularly during group discussions and practicums. In the first meeting of the experimental class, students discussed video observations of the practicum on the effects of the environment on mung bean seeds. In the second meeting, a discussion was held regarding the levels of organization and energy flow, where students analyzed the role of living things in food webs through augmented reality and created food chains in the surrounding environment. In the third meeting, students explored the interactions of living things using augmented reality. In the fourth meeting, a discussion was held regarding the impact of human activities on ecosystems, during which students analyzed climate change and created mind maps to inform climate change prevention efforts. In the final meeting, students discussed biodiversity conservation and created posters related to environmental conservation actions.

The results of the collaborative skills of students in the experimental and control classes showed differences, with the experimental class achieving higher results for each indicator. This suggests that learning in a self-organized learning environment (SOLE) model, integrated with the thinking actively in a social context (TASC) model, is more effective in developing collaborative skills compared to conventional learning. This finding is supported by Fazhari & Yuniawatika (2025), who emphasized that the right learning model and approach can foster collaborative skills while increasing participation in an interactive learning environment. Rahayu (2021) also explained that the implementation of SOLE encourages students to learn from each other and collaborate in answering inquiry questions using the internet, while Murwaningsih & Fauziah (2021) added that TASC provides a space for meaningful collaborative practice. Thus, the higher student enthusiasm in the experimental class is one factor contributing to better collaboration scores compared to the control class. A description of the improvement in each indicator of student collaboration skills is outlined below.

The first indicator of collaborative skills is actively contributing, including expressing ideas, responding to ideas, and assisting group members. Results showed a higher increase in this indicator in the experimental class compared to the control. This is influenced by the implementation of the self-organized learning environment (SOLE) model, integrated with thinking actively in a social context (TASC), which encourages students to engage in active discussion. The question and investigation stages in SOLE train students to answer questions, discuss, and present results, which fosters curiosity (Asmawati et al., 2021) and develops collaboration skills (Azizah, 2022). Meanwhile, the gather/organize, identify, and generate stages in TASC train students to gather information, formulate questions, and discuss solutions (Muqsith & Maulana, 2022). However, passive students are still found due to a lack of understanding of the material, so the teacher's role is crucial in creating a conducive classroom and providing opportunities for students to ask questions (Hasanah & Hasruddin, 2024).

The improvement in the indicator of actively contributing to this higher experimental class is due to the implementation of the TASC integrated SOLE model, which can train students to be active in the learning process, especially when discussing worksheets. This can be

observed during learning, where students are given problems related to images of wilted and fresh plants, and then asked to analyze the causes of the differences in these plants. Some students in the experimental class are able to share their opinions with each other, allowing them to formulate the causes of the differences that occur. During the discussion process, students are trained to share and respond to one another's opinions regarding the problems that arise.

The second indicator is flexibility, demonstrated by the ability to accept decisions, adapt to changing circumstances, and compromise during discussions. The percentage of improvement in the experimental class was greater than in the control class because the TASC-integrated SOLE model provides students with space to adapt during discussions. In the investigation (SOLE) and generate–decide–implement (TASC) stages, students discuss, determine ideas, and divide tasks according to agreement. Fauziah et al. (2020) emphasized that TASC can encourage positive interactions and support between students. Although the control class also showed improvement, some students remained passive due to limited understanding of the material. In this lesson, students created mind maps related to climate change crisis prevention efforts that can be implemented in everyday life. In this activity, students were given the freedom to express their thoughts and ideas during the discussion and mind mapping process. Therefore, this fostered flexibility in the discussions. Some students in the experimental class were able to adapt when completing the assignment.

The third indicator is working productively, namely focusing on completing tasks, answering worksheets in detail, and on time. The improvement in the experimental class was higher because SOLE–TASC trains students to divide tasks and explore materials through augmented reality or video. Students are more focused, and the discussion results are more detailed. Furthermore, indicators of productive work are also demonstrated by students submitting their worksheets within the allotted time. In the investigation (SOLE) stage, students search for answers using the internet (Raranta, 2022), while in the generate–decide–implement (GDI) stage, students discuss, select ideas, and complete tasks together. According to Fauziah et al. (2020), TASC helps students experiment, consider alternatives, and plan actions to complete tasks in a more focused manner than conventional learning.

The fourth indicator is responsibility, which encompasses completing assignments as agreed upon, maintaining orderliness, and adhering to group activities. Improvement in the experimental class was higher, as evidenced by the sharing of assignments through video-based or augmented reality worksheets. Each student explores their assigned tasks and shares ideas and feedback related to them. The investigation and review (SOLE) stage trains students to complete assignments according to their roles and present results. Marlina (2021) emphasized that in SOLE, the teacher acts as a facilitator, while students are responsible for completing the assignments. In TASC, the implement–evaluate–learn-of-experience stage trains students to divide assignments, examine results, and reflect on learning. This aligns with Fauziah et al. (2020), who emphasized the importance of group discussions to find joint solutions.

The fifth indicator is respect, which encompasses accepting group ideas, refraining from imposing one's will, and avoiding discrimination against others. The percentage increase in this indicator in the experimental class was higher, although relatively small, compared to the other indicators, because cultivating respect takes a considerable amount of time (Aninda et al., 2020). In the investigation and review (SOLE) stage, students discuss, convey, and respond to opinions, then present the results. According to Akbar et al. (2023), this activity trains students

to respect each other. Meanwhile, the generate and communicate (TASC) stage provides students with the opportunity to exchange opinions, present, and provide feedback. Fauziah et al. (2020) emphasized that TASC enables students to provide feedback, think critically, and ask questions, thereby developing their respect skills. Learning activities that encourage students to demonstrate respect include group discussions. This teaches students to respect each other's opinions and to refrain from imposing their own will on others.

The results of the collaborative skills analysis conducted showed that most participants were trained to be skilled in collaboration, especially in discussions in the experimental class. Rahayu (2021) explained that the application of the SOLE model in the learning process can encourage students to learn from each other and work together as a group to answer inquiry questions that spark a spirit of learning through an internet connection. This is supported by Murwaningsih & Fauziah (2022), who stated that the use of TASC in the learning process can provide opportunities for students to collaborate. Collaboration in learning groups can occur through students working together to complete assignments, providing information or encouragement to group members who are experiencing difficulties (Fazhari & Yuniatika, 2025).

Differences in the Improvement of Students' Communication Skills in the Experimental Class and the Control Class

Oral communication skills are essential for applying in the science learning process, enabling students to engage in communicative and active learning, and deepen their knowledge (Muamala & Wulandari, 2024). In the first lesson of the experimental class, students were taught to create presentations based on video observations of the environmental impact of mung bean seeds. In the second learning session, a presentation was held on the levels of organization and energy flow, where students explained the role of living things in the food web through augmented reality and created a food chain in the surrounding environment. In the third learning activity, students made a presentation related to the analysis of interactions between living things using augmented reality. In the fourth learning session, a presentation was held on the analysis of the impact of human activities on the ecosystem. During this session, students explained the causes of climate change and discussed mind mapping efforts aimed at mitigating it. In the final learning session, participants were taught to create presentations related to biodiversity conservation and posters related to environmental conservation actions.

The results showed that all communication indicators in the experimental class demonstrated a higher level of improvement compared to the control class. This finding confirms that the implementation of the SOLE model integrated with TASC has a positive impact on students' communication skills. Fikri (2022) explained that discussion and presentation activities in the SOLE model effectively train communication skills, while Fauziah et al. (2020) emphasized that TASC encourages students to convey discussion results to obtain feedback. Due to the difference in treatment between the experimental and control classes, the communication indicator scores in the control class were relatively lower. An explanation of the improvement in each indicator of students' collaboration skills is outlined below.

The first indicator of communication skills is delivering a clear presentation, with three sub-indicators: conveying main points, using accessible language, and presenting group discussion results. Improvement in this indicator was higher in the experimental class than in the control class because the implementation of the self-organized learning environment

(SOLE) model, integrated with thinking actively in a social context (TASC), trains students to be active, particularly through video and augmented reality exploration. This activity enables students to better understand the material and explain the results in simple language. Relevant SOLE syntax includes the investigation and review stages, where students discuss the worksheet contents and present their findings. Rahayu (2021) emphasized that presentations in SOLE encourage the use of flexible language, thus improving communication skills. In TASC, the generate, decide, implement, and communicate stages require students to discuss, make decisions, divide tasks, and present results (Muqsith & Maulana, 2022).

The second indicator is mastery of the material, which encompasses the ability to present, analyze, and evaluate information effectively. The improvement in the experimental class was higher because the self-organized learning environment (SOLE) model, integrated with thinking actively in a social context (TASC), provided students with a space to actively explore, create mind maps, and posters. Students are trained in presenting, analyzing, and playing back the material presented. This differs from the control class, which passively listened to teacher explanations. SOLE's syntax in the investigation and review stages trains students to explore material online and then present it. Matovani et al. (2022) showed that SOLE encourages independent learning, resulting in a better understanding of the material. In TASC, the gather, generate, and implement stages train students to gather information, discuss, and divide tasks to deepen understanding. Fauziah et al. (2020) emphasized that exploration and hands-on practice activities in TASC strengthen material understanding.

The third indicator is the ability to answer questions clearly, logically, and appropriately. Improvement in the experimental class was higher because students were trained to search for information independently through video barcodes and augmented reality in the student worksheet. Through these activities, students can gain a deeper understanding of the exploration results, making it easier for them to answer questions. The supporting SOLE syntax involves the question, investigation, and review stages, where students are encouraged to ask questions, explore answers, and present their findings. This aligns with Hasanah & Hasruddin (2024) who emphasize the importance of active involvement in practicing answering skills. In TASC, the identify, generate, and implement stages train students to discuss questions, express opinions, and seek relevant information. Fauziah et al. (2020) explain that the generate and implement stages direct students to consider alternative answers before submitting them.

The fourth indicator is openness to criticism and suggestions, which includes providing opportunities for argumentation, accepting feedback, and revising opinions when necessary. Improvement in the experimental class was higher because the self-organized learning environment (SOLE) model, integrated with thinking actively in a social context (TASC), provided a discussion space that encouraged students to respond to ideas, accept suggestions, and refine their thinking. Students share and share their opinions with each other during group discussions, mind map creation, or poster creation while completing worksheet assignments. The SOLE syntax in the investigation and review stages emphasizes appreciation and completion of presentation results between groups (Asmawati et al., 2021). In TASC, the evaluation and learning from experience stages train students to assess the problem-solving process and reflect on learning experiences. Fauziah et al. (2020) emphasized that the evaluation stage helps students develop alternative actions based on the criticism received.

The analysis of communication skill improvement conducted after implementing the integrated TASC SOLE model revealed that most students possessed good communication skills, as indicated by the indicators. Fikri (2022) explained that the learning activities in the

SOLE model are varied, including discussions and presentations, to train students' communication skills. This is supported by Fauziah et al. (2020), who stated that using TASC in the learning process enables students to communicate the results of class discussions, thereby obtaining input and suggestions.

The Relationship between Collaboration Skills and Communication Skills after the Implementation of the SOLE-TASC Model

Collaboration and communication skills have a positive and significant relationship in students who are in the very strong category. The implementation of the self-organized learning environment (SOLE) model, integrated with thinking actively in a social context (TASC), involves group discussions and presentations that allow students to actively contribute, exchange opinions, and provide and receive constructive criticism or suggestions. This process not only trains collaboration skills but also improves communication skills, as students must convey the results of discussions clearly and logically. Exploration activities related to the material, including the influence of the environment on ecosystems, food chains, interactions between living things, climate change, and environmental conservation, facilitated through augmented reality and other learning media, enable a deeper understanding of concepts. This allows students to clearly articulate their group's ideas and findings during presentations. This aligns with Muamala & Wulandari (2024), who stated that group collaboration can develop communication skills, increase thinking skills, self-confidence, interest, social awareness, and respect for differences. Students' collaboration skills are evident in science learning through group discussions. Furthermore, communication skills are also evident in science learning when students present the results of their discussions.

These findings also support Hasanah & Hasruddin (2024), who stated that a collaborative learning environment encourages passive students to become active participants in discussions and answer questions, thereby improving their communication skills. Tekad & Pebriana (2022) added that good collaboration skills in group assignments can build student communication, while Thahir (2024) emphasized that effective communication enables students to convey knowledge, ideas, and thoughts clearly and logically. Thus, the implementation of the SOLE model, which integrates the TASC model, not only improves collaboration but also significantly strengthens communication skills through active interactions and structured presentation activities.

CONCLUSION

Based on the research results, the implementation of the self-organized learning environment (SOLE) model, integrated with thinking actively in a social context (TASC), significantly improved students' collaboration and communication skills compared to conventional learning methods. A strong positive correlation was observed, indicating that effective collaboration skills support the development of improved communication skills. However, some skills, particularly in the in-depth application of concepts and full mastery of collaborative processes, were still not fully achieved by all students. This finding emphasizes the importance of optimizing learning with the SOLE model integrated TASC model in other science materials, for example, by preparing more challenging guiding questions and more structured group presentation activities, to maximize skill achievement. Further research is recommended to explore the effect of this model on indicators of critical thinking skills and

learning independence, as well as to develop instruments that can capture variations in student skills in more depth.

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