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The Role of Communication Skills in Mediating the Influence of Learning Models on the Science Literacy of Elementary School Students

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Abstract
This study examines the mediating role of communication skills in the relationship between learning models and the scientific literacy of fifth-grade elementary students in IPAS learning. Using a quantitative ex post facto correlational design, data were collected from 120 students through observation sheets, communication skill rubrics, and scientific literacy tests. The study implemented active learning models such as Problem Based Learning (PBL), RADEC, and concept-map-based SETS, with data analyzed using path analysis assisted by AMOS software. The results revealed that learning models significantly affected communication skills and scientific literacy. Path analysis showed that communication skills acted as a significant mediating variable, where the indirect effect of learning models on scientific literacy was stronger than the direct effect. Students involved in active and inquiry-based learning demonstrated higher achievement in explaining scientific phenomena and interpreting scientific data compared with students in conventional learning. These findings indicate that strengthening communication skills is an important strategy for improving elementary students' scientific literacy.
Keywords: *Scientific literacy, communication skills, learning models, elementary education, IPAS.*

Abstrak
Penelitian ini bertujuan untuk menguji peran mediasi keterampilan komunikasi dalam hubungan antara model pembelajaran dan literasi sains peserta didik kelas V pada pembelajaran IPAS. Penelitian menggunakan pendekatan kuantitatif dengan desain ex post facto korelasional. Data dikumpulkan dari 120 peserta didik melalui lembar observasi, rubrik keterampilan komunikasi, dan tes literasi sains. Model pembelajaran yang diterapkan meliputi Problem Based Learning (PBL), RADEC, dan SETS berbasis peta konsep. Analisis data dilakukan menggunakan analisis jalur (path analysis) dengan bantuan perangkat lunak AMOS. Hasil penelitian menunjukkan bahwa model pembelajaran berpengaruh signifikan terhadap keterampilan komunikasi dan literasi sains peserta didik. Hasil analisis jalur juga menunjukkan bahwa keterampilan komunikasi berperan sebagai variabel mediasi yang signifikan, di mana pengaruh tidak langsung model pembelajaran terhadap literasi sains lebih kuat dibandingkan pengaruh langsungnya. Peserta didik yang mengikuti pembelajaran aktif dan berbasis inkuiri menunjukkan kemampuan yang lebih baik dalam menjelaskan fenomena ilmiah dan menginterpretasikan data ilmiah dibandingkan peserta didik pada pembelajaran konvensional. Temuan ini menunjukkan bahwa penguatan keterampilan komunikasi menjadi strategi penting dalam meningkatkan literasi sains peserta didik sekolah dasar.
Kata kunci: *literasi sains, keterampilan komunikasi, model pembelajaran, pendidikan dasar, IPAS.*

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INTRODUCTION

The development of science and technology in the 21st century has transformed the orientation of education from merely transferring knowledge to fostering critical, creative, and communicative thinking skills. The challenges of globalization, digitalization, and the complexity of social issues demand that learners possess scientific thinking abilities to adapt to the changing times. In this context, scientific literacy becomes an essential basic competency that enables students to understand natural and social phenomena around them and make decisions based on evidence and rational arguments (OECD, 2023).

Basic education holds a strategic role in developing scientific literacy, as it is at this level that students are first introduced to scientific concepts and logical reasoning. Through the Natural and Social Sciences (IPAS) subject included in the Merdeka Curriculum, students are expected not only to understand scientific concepts but also to apply them in real life. The Merdeka Curriculum emphasizes student-centered learning through scientific, inquiry-based, and collaborative project approaches. The goal is to equip learners with critical and scientific reasoning skills as part of the Pancasila Student Profile (Ministry of Education, Culture, Research, and Technology, 2022).

However, empirical evidence shows that the scientific literacy of Indonesian elementary school students remains at a low level. The 2018 Programme for International Student Assessment (PISA) reported that the average science literacy score of Indonesian students was only 396, far below the OECD average of 489 (OECD, 2019). National data from the Minimum Competency Assessment (AKM) indicate a similar trend, with most students still struggling to interpret scientific information and relate scientific concepts to real-life situations (Suryani & Widodo, 2023). This condition suggests that elementary learning has not yet optimally developed students' scientific thinking and scientific communication skills, which are essential components of scientific literacy.

The low level of students' scientific literacy is influenced not only by limited conceptual understanding but also by the implementation of learning models that provide insufficient opportunities for interaction, discussion, and scientific exploration. In many elementary schools, IPAS instruction remains teacher-centered and relies heavily on lectures and drill-based activities (Abidin, 2023). As a result, students tend to become passive learners who rarely ask questions, express opinions, or engage in scientific dialogue. Meanwhile, scientific literacy requires active participation, inquiry processes, and meaningful communication in constructing scientific understanding.

Although previous studies have reported that active learning models such as Problem Based Learning (PBL), RADEC, and SETS can improve scientific literacy, most studies primarily focus on the direct effect of learning models on learning outcomes. Limited research has specifically examined the mediating role of communication skills in strengthening the relationship between learning models and scientific literacy, particularly at the elementary school level within the context of the Merdeka Curriculum. Therefore, this study is important to provide empirical evidence regarding how communication skills function as a mediating factor in improving students' scientific literacy through active learning models.

One factor that can strengthen scientific literacy is the use of active learning models. The Problem-Based Learning (PBL), Read–Answer–Discuss–Explain–Create (RADEC), and SETS (Science, Environment, Technology, Society) models have been shown to positively influence students' conceptual understanding, motivation, and scientific thinking skills (Amalia & Prasetyo, 2022; Pradana & Sari, 2025). Problem-based learning enables students to discover and clarify concepts through contextual situations, during which they develop critical thinking skills and collaborate to solve real-world problems (Hastuti et al., 2023).The RADEC model integrates reading, answering,

discussing, explaining, and creating into a coherent learning process that trains students to formulate ideas and express them in scientific written form (Maulana, 2023). Meanwhile, the SETS model emphasizes the interconnectedness of science, environment, technology, and society, so that scientific literacy grows through an understanding of the relationship between scientific concepts and social life (Rahmawati & Wibowo, 2022).

However, the effectiveness of these active learning models greatly depends on the communication skills possessed by students, where communication in the context of science learning includes the ability to express ideas orally and in writing, to listen, to respond to arguments, and to participate in scientific discussions. According to Fitriani and Kurniawan (2021), scientific communication serves as a bridge between knowledge and understanding; through this ability, learners process information and construct meaning from their learning experiences. Vygotsky (1986) further emphasizes that individual thinking skills are formed through social interaction mediated by language, so that communication functions as the primary means for the development of cognitive abilities.

Communication skills are not only a learning goal but also a mediator that links various learning processes, because when students are able to express ideas, ask questions, and respond to their peers' views, they are in fact revising and strengthening their cognitive structures. Research by Anisa and Setiadi (2021) found that effective communication in the classroom contributes significantly to conceptual understanding in project-based learning, while Handayani and Lestari (2024) further showed that collaboration and scientific communication in small groups can increase students' confidence and encourage more active engagement in learning science. Therefore, strong communication skills become essential capital for optimizing the impact of learning models on scientific literacy.

Various classroom observations indicate that Indonesian elementary students' communication skills remain relatively low, as many are reluctant to ask questions or express opinions due to learning environments that have not yet fostered a culture of discussion and open thinking (Fitriani & Kurniawan, 2021). Teachers often focus more on delivering content and achieving final outcomes than on communication processes that involve scientific dialogue (Sativa & Eliza, 2023). Yet discussion and presentation activities are essential components in building students' scientific literacy because they provide structured opportunities to articulate ideas, justify claims, and negotiate meaning with peers.

From a social constructivist perspective, the success of science learning depends heavily on the linguistic interactions that occur in the classroom, where communication functions as a tool for sharing experiences, contrasting ideas, and negotiating scientific meaning (Vygotsky, 1986). In active learning models such as PBL, RADEC, and SETS, communication is not merely an outcome of learning but an integral part of the strategy for constructing understanding, because when students discuss experimental results, they articulate the relationship between their prior knowledge and new observations. This process not only deepens individual understanding but also develops scientific thinking skills in a socio-cognitive manner (Yulianti & Hidayat, 2024).

However, in many elementary classrooms, scientific communication activities have not been optimally implemented, as learning still tends to focus on content delivery rather than reflective discussion and student interaction. As a result, students often experience difficulties in expressing scientific ideas, explaining observations, and constructing evidence-based arguments. This condition becomes increasingly important in the implementation of the Merdeka Curriculum, which emphasizes inquiry, collaboration, and student-centered learning. Therefore, research examining the role of communication skills in mediating the relationship between active learning models and scientific literacy is urgently needed to provide empirical evidence and practical guidance

for developing more interactive and meaningful IPAS learning at the elementary school level.

Previous studies have demonstrated that scientific communication is directly associated with science literacy achievement, with Lestari and Nugroho (2013) reporting that communication skills play an important role in developing students' ability to explain scientific phenomena and design investigations. Similarly, Theobald et al. (2021) found that communication variables in science instruction can mediate the relationship between inquiry-based learning activities and improvements in students' cognitive outcomes. However, these studies have mostly been conducted at secondary education levels, so empirical evidence at the elementary school level remains limited, particularly within the context of the newly implemented Merdeka Curriculum.

The fact that most IPAS instruction in Indonesian elementary schools still follows conventional patterns makes research on the role of communication in science learning highly relevant, as teachers tend to emphasize factual knowledge without elaborating scientific processes and reflective dialogue. Utami and Pratama (2024) highlight that teachers need concrete guidelines for integrating scientific communication strategies into inquiry- and project-based learning models so that classroom interaction can more effectively support higher-order thinking. Through such approaches, students are expected not only to understand scientific concepts but also to learn how to speak and write using appropriate scientific language in a structured and accurate manner.

Strengthening scientific communication impacts not only learning outcomes but also the development of students' scientific character, because communication enables learners to cultivate curiosity, respect others' opinions, and confidently present arguments supported by evidence. Consequently, early investment in scientific communication can be viewed as a long-term strategy for building a robust scientific civilization in Indonesia (Abidin, 2023).

A deeper empirical analysis of the role of communication in strengthening science literacy can also provide a solid foundation for developing a curriculum grounded in 21st-century competencies, in line with national education policy directions that define learning success not only in terms of knowledge acquisition but also in terms of students' abilities to think critically, collaborate, and communicate effectively. At the elementary school level, this orientation is reflected in IPAS instruction that seeks a balance between conceptual knowledge, scientific processes, and social-communicative skills so that students learn science while simultaneously practicing interaction and expression in meaningful contexts.

Within this context, a study on the Role of Communication Skills in Mediating the Influence of Learning Models on the Science Literacy of Elementary School Students becomes crucial, because it offers both empirical and theoretical contributions to explaining the mechanisms through which active learning models can enhance science literacy via scientific communication pathways. The novelty of this study lies in its focus on communication skills as a mediating variable in the relationship between learning models (PBL, RADEC, and SETS) and science literacy at the elementary school level within the implementation of the Merdeka Curriculum, which has rarely been empirically examined using a path analysis approach. The findings of such research are expected to provide concrete recommendations for teachers, schools, and policymakers in designing IPAS learning strategies that are more participatory and communicative, and that align with the spirit of the Merdeka Curriculum in promoting learner agency and meaningful engagement with scientific ideas.

METHOD

This study employs a quantitative approach with an ex post facto correlational design to examine the influence of learning models on students' science literacy as mediated by communication skills, a design that enables analysis of causal relationships

among variables without direct manipulation so that classroom conditions remain natural (Rahmawati & Wibowo, 2022). The research subjects are fifth-grade elementary students who have participated in IPAS lessons using various innovative models such as Problem Based Learning (PBL), RADEC, and concept-map-based SETS, with a sample of 120 students selected through cluster random sampling from several public elementary schools in urban areas.

The research instruments consist of three main components: first, observation sheets and learning-model questionnaires that measure the intensity of active model implementation, including problem orientation, inquiry activities, collaboration, and reflection (Pradana & Sari, 2025). Second, communication-skill instruments in the form of observation rubrics and questionnaires that assess students' abilities to engage in discussion, ask questions, respond to peers' opinions, and present ideas orally and in writing (Fitriani & Kurniawan, 2021). Third, a science-literacy test developed based on PISA indicators and IPAS content in the Merdeka Curriculum to measure students' ability to explain scientific phenomena, design investigations, and interpret data (Hasibuan, 2025), with instrument validity established through expert judgment and reliability estimated using Cronbach's Alpha coefficients above 0.8, indicating high internal consistency.

Research data were collected through observation of learning activities, the administration of questionnaires, and the implementation of a science literacy test after the completion of the learning sessions. The data were then analyzed in stages using path analysis to examine direct and indirect effects among variables, with the assistance of SPSS and AMOS software and prerequisite tests for normality, linearity, and multicollinearity carried out beforehand. The mediating effect size of communication skills was tested using a bootstrapping procedure with a significance level of 0.05 to ensure the stability of the parameter estimates (Lestari & Nugroho, 2013).

RESULTS AND DISCUSSION

The findings of this study demonstrate that active learning models implemented in IPAS instruction significantly contributed to the improvement of students' communication skills and science literacy. Quantitative analysis showed that the implementation of Problem Based Learning (PBL), Read–Answer–Discuss–Explain–Create (RADEC), and Science, Environment, Technology, and Society (SETS) models created more interactive and student-centered learning environments, encouraging learners to actively participate in scientific discussions, investigations, and reflective activities.

Descriptive statistical analysis revealed differences in the characteristics of communication skills developed in each school. Students at SD Negeri Puhgogor 01, where PBL and RADEC were more intensively implemented, demonstrated higher oral communication abilities, particularly in asking questions, responding to peers' opinions, and explaining scientific concepts during classroom discussions. The average oral communication score reached 82.4, categorized as high. In contrast, students at SD Negeri Puhgogor 02, which emphasized SETS-oriented experimental and project-based activities, showed stronger written communication abilities with an average score of 81.3, especially in preparing observation reports, interpreting experimental findings, and presenting data systematically through tables and graphs. These findings indicate that different active learning models may strengthen different dimensions of scientific communication.

The results of the science literacy test also demonstrated positive outcomes. Students from both schools achieved science literacy scores within the medium-to-high category, with an overall average score of 78.6. Students exposed to RADEC and PBL models showed stronger abilities in explaining scientific phenomena using contextual examples from everyday life, while students involved in SETS-based instruction

performed better in interpreting scientific data and drawing conclusions from experiments. For instance, students at SD Negeri Puhgogor 01 were more capable of explaining the process of photosynthesis and energy transformation in simple scientific language, whereas students at SD Negeri Puhgogor 02 excelled in analyzing temperature measurements and interpreting environmental observation data. These findings suggest that integrating inquiry-based learning with communication-oriented activities contributes positively to the development of students' science literacy.

The path analysis results further confirmed the hypothesized relationships among the variables. Active learning models had a significant direct effect on communication skills ($\beta = 0.61$; $p < 0.05$), indicating that students who participated more actively in collaborative inquiry and discussion activities tended to demonstrate higher communication competence. In addition, active learning models also had a direct effect on science literacy ($\beta = 0.47$; $p < 0.05$). However, the indirect effect mediated through communication skills ($\beta = 0.32$) was found to be stronger than the direct effect alone, indicating that communication skills function as a significant mediating variable in strengthening students' science literacy.

These findings support the social constructivist perspective proposed by Lev Vygotsky, which emphasizes that cognitive development occurs through social interaction mediated by language and communication. In the context of IPAS learning, discussion activities, scientific presentations, peer explanations, and collaborative investigations provided opportunities for students to negotiate meaning, construct scientific understanding, and refine their reasoning processes. Communication therefore functions not merely as a tool for delivering information, but also as a mechanism for constructing scientific knowledge itself.

The findings of this study are consistent with previous research. The positive influence of Problem Based Learning on science literacy aligns with the findings of Pradana and Sari (2025), who reported that inquiry-oriented learning significantly improves elementary students' ability to explain scientific phenomena and solve contextual problems. Similarly, the findings support Rahmawati and Wibowo (2022), who found that SETS-based learning enhances communication skills and scientific reasoning through contextual exploration activities. Furthermore, the mediating role of communication skills in this study is in line with the research conducted by Theobald et al. (2021), which demonstrated that communication variables significantly mediate the relationship between inquiry-based instruction and students' cognitive achievement in science education.

The present findings also reinforce the argument of Fitriani and Kurniawan (2021) that scientific communication serves as a bridge between conceptual understanding and scientific reasoning. Students who were actively involved in questioning, discussing, explaining, and presenting scientific ideas demonstrated better conceptual mastery compared with students who participated passively in classroom activities. This condition was particularly evident during group discussions and presentation sessions, where students who confidently articulated arguments and responded to peers' questions showed stronger scientific reasoning abilities.

In addition, classroom observations indicated that contextual learning media strengthened the relationship between communication skills and science literacy. Teachers at SD Negeri Puhgogor 01 frequently used videos, real-life problems, and concrete objects as discussion stimuli, while teachers at SD Negeri Puhgogor 02 integrated simple experimental tools such as thermometers, magnifying glasses, and environmental observation materials into learning activities. These media encouraged students to communicate observations systematically and helped them connect abstract scientific concepts with real-life situations. This finding supports Susanti et al. (2025), who concluded that contextual media-based instruction increases student engagement and improves the clarity of scientific communication.

Another important finding of this study concerns the variation in communication patterns produced by different instructional approaches. RADEC-oriented instruction tended to strengthen oral communication and reflective discussion skills because students were frequently required to discuss and explain concepts collaboratively. Meanwhile, SETS-oriented instruction emphasized systematic reporting and contextual analysis, thereby strengthening written communication skills and data interpretation abilities. This finding suggests that combining reflective discussion activities with structured scientific reporting may provide a more comprehensive strategy for developing students' science literacy.

Overall, the findings of this study indicate that communication-centered IPAS instruction creates more meaningful learning experiences and significantly contributes to the development of students' science literacy. Scientific communication not only emerges as a learning outcome but also acts as a driving force that facilitates scientific reasoning, conceptual understanding, and collaborative knowledge construction. Therefore, the success of active learning models in improving science literacy largely depends on the extent to which learning activities provide opportunities for students to actively communicate scientific ideas through discussion, presentation, inquiry, and reflective interaction.

These findings carry important implications for the development of instructional strategies at the elementary level, suggesting first that teachers should position scientific communication as a core component in lesson planning so that each phase of instruction includes structured discussion or reflection activities. Second, schools need to support cross-subject collaboration mechanisms so that scientific communication is not confined to IPAS, but is also integrated into Indonesian language and civics lessons, enabling students to practice argumentation and evidence-based reasoning across different curricular contexts. Third, the results can serve as a basis for teacher training programs focused on developing facilitation skills for data-driven scientific discussions that encourage students to justify claims using empirical evidence.

Thus, this study reinforces the argument that improvements in students' science literacy can only be achieved if schools cultivate a learning culture that actively promotes scientific communication, positioning talk and writing about science as central rather than peripheral activities. The cases of SD Negeri Puhgogor 01 and SD Negeri Puhgogor 02 demonstrate that students' active engagement in scientific dialogue provides an effective pathway for building conceptual understanding, critical thinking skills, and scientific character, illustrating that communication is not merely an add-on to instruction but a foundational condition for nurturing a scientifically literate, collaborative, and reflective generation of learners.

CONCLUSION

This study demonstrates that active learning models have a significant effect on elementary students' communication skills and science literacy in IPAS, with the implementation of Problem Based Learning (PBL), RADEC, and concept-map-based SETS increasing participation, communication abilities, and science literacy achievement. These findings affirm that instructional effectiveness is determined not only by the content taught, but also by how teachers design and manage learning experiences that foster interaction, exploration, and scientific communication as integral parts of the classroom process.

Communication skills are shown to function as a mediating variable between learning models and science literacy, with the indirect effect of active learning models on science literacy through communication found to be significant, indicating that improving students' communication abilities is a primary pathway for strengthening the impact of instruction on IPAS learning outcomes. This pattern suggests that communication is not merely a channel for transmitting information, but an integral component of scientific

thinking and meaning construction, as learners articulate, negotiate, and refine their understanding through spoken and written scientific discourse.

Theoretically, these findings support the social constructivist view that scientific knowledge is built through social interaction, with language serving as a central tool for thinking and mediating cognitive development. In the context of IPAS instruction, scientific discussions, presentations, and peer explanations function as key mechanisms for internalizing science concepts, while practically, teachers need to structure lessons that stimulate idea expression, logical argumentation, and two-way communication among students in order to strengthen science literacy in a sustained manner.

The implications of this study point to the need to strengthen teachers' roles as facilitators of scientific communication in the classroom, with IPAS teachers encouraged to design inquiry- and project-based learning activities that prompt students to ask questions, explain their observations, and write scientific reflections in alignment with Merdeka Curriculum principles. Schools can support this by providing ongoing professional development on the implementation of active learning models that explicitly integrate scientific discussion, presentation, and evidence-based writing as core components of IPAS instruction.

For future research, it is recommended to expand the sample to different grade levels and school contexts, and to include additional variables such as motivation or learning-environment support in order to obtain a more comprehensive conceptual model. The development of innovative learning materials grounded in science literacy and scientific communication can also become a promising focus for subsequent studies, particularly to explore how such materials function in diverse classroom settings.

Overall, this study affirms that improvements in students' science literacy can only be achieved when IPAS instruction places scientific communication at the core of the learning process, treating speaking and writing about science as fundamental learning activities rather than supplementary tasks. Teachers, schools, and policymakers are therefore expected to prioritize communication skills as a strategic focus in developing 21st-century science literacy, ensuring that classroom practices systematically foster students' abilities to argue, explain, and interpret scientific information.

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