

Strengthening Science Literacy Through Academic Supervision: Insights from High School Science Teachers

Iriwi Louisa S. Sinon¹, Maisyaroh², Rochmawati²

i.sinon@unipa.ac.id, maisyaroh.fip@um.ac.id, rochmawati.fip@um.ac.id

¹Faculty of Teacher Training and Education, Universitas Papua, Manokwari, Indonesia

²Faculty of Education, Universitas Negeri Malang, Malang, Indonesia

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ABSTRACT

Academic supervision is a systematic professional development process aimed at enhancing instructors' pedagogical and professional competencies through guidance and reflection. In the context of educational challenges in West Papua, including geographical and resource constraints, comprehending teacher attitudes poses a difficulty for supervisory tactics. This study aims to investigate the perspectives of physics teachers regarding the application of academic monitoring in public and private high schools in West Papua to strengthening scientific literacy. The employed research methodology is qualitative, utilising a case study approach. Data were gathered via comprehensive interviews with nine Physics Science educators to investigate their experiences, reactions, and anticipations regarding the academic supervision process. The study's findings indicated that teacher perceptions were significantly affected by the supervisory approach, the quality of communication between teachers and supervisors, and the pertinence of the feedback provided. Educators possess adequate comprehension of the design, execution, and evaluation of academic oversight by the principal. Favourable perceptions typically foster educators' receptiveness to transformation and enhancement of instructional methodologies. It is essential for principals to comprehend the scientific content pertinent to the subject matter taught by each educator, particularly regarding scientific literacy (scientific approach). Supervisor competencies that diverge from the relevant field of study also impede the efficacy of supervision. This study theoretically enhances the discussion on teacher perceptions in academic supervision. The findings can serve as a resource for educational stakeholders to design a more contextual and effective supervision model, particularly in regions with distinct socio-cultural and infrastructural situations like West Papua.

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Corresponding Author:

Iriwi Louisa S. Sinon
Physics Education Study Program, Faculty of Teacher Training and Education
Universitas Papua
Jl. Gunung Salju, Amban Manokwari, Papua Barat Indonesia
Email: i.sinon@unipa.ac.id

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Introduction

Improving the quality of education remains a central priority in national and global education agendas, particularly in strengthening students' higher-order thinking and scientific literacy skills. In Indonesia, school principals are formally mandated to ensure instructional quality through academic supervision, as stipulated in the Regulation of the Minister of National Education (Julianda et al., 2024; Haris et al., 2018). These regulations position supervision not merely as administrative oversight but as a managerial and professional competency that includes planning supervision programs, conducting systematic observations, and implementing follow-up actions to enhance teacher professionalism. Conceptually, academic supervision is widely recognized as a developmental and collegial process aimed at improving instructional practice and student learning outcomes (Glickman et al., 2017; Akudo, 2025). It emphasizes professional dialogue, reflective practice, and instructional support rather than fault-finding or bureaucratic compliance especially in individual or group (Setyaningsih & Suchyadi, 2021; Tutupary, 2021). Therefore, effective supervision is closely linked to the continuous improvement of teaching quality, particularly in subject areas that demand complex pedagogical and content knowledge, such as Physics.

In the context of 21st-century education, science teaching must go beyond content transmission to cultivate scientific literacy that defined as the ability to apply scientific knowledge, interpret data, think critically, and make evidence-based decisions in real-life contexts (Öztürk, 2023; Rochmawati et al., 2019). Scientific literacy has become a key global benchmark for educational quality and competitiveness (Wu, 2025; Yao & Guo, 2018). However, many high school science teachers encounter substantial challenges in implementing literacy-oriented instruction (Meo et al., 2024; Kollas & Halkia, 2020). These include dense curricula, limited laboratory facilities, time constraints, insufficient professional development, and students' low motivation toward physics. Inquiry-based and contextual learning approaches is essential for fostering scientific literacy which are often underutilized due to limited pedagogical support and inadequate ongoing supervision (Wicaksono et al., 2025; Machado & Nahar, 2023; Riga et al., 2017). As a result, academic supervision has the potential to serve as a strategic mechanism to strengthen teachers' instructional competence and support the integration of scientific literacy into classroom practice.

Previous studies have demonstrated that supervision can enhance teacher competence, curriculum implementation, and learning evaluation (Said, 2025; Hidayat et al., 2024; Ameli et al., 2024; Lorensius et al., 2022; Setia & Nasrudin, 2020). Nevertheless, existing research has predominantly examined supervision from the perspective of principals or supervisors, focusing on procedural implementation and managerial effectiveness (Hepriyanti et al., 2023; Arsana et al., 2019). The voices of teachers, the primary recipients of supervision, remain underexplored, particularly in geographically and socio-culturally diverse regions. This represents a significant research gap, as teachers' perceptions are critical in determining whether supervision is experienced as supportive professional development or as evaluative control. Moreover, limited empirical evidence addresses how academic supervision specifically contributes to improving science literacy skills in Physics education, especially within remote and resource-constrained contexts.

This gap is particularly evident in West Papua Province, a region characterized by complex geographical conditions, dispersed school locations, limited access to supervisory services, and diverse socio-cultural backgrounds (Amir, 2020; Frank & Idris, 2020; Elmslie, 2017; Baransano et al., 2016). Such contextual realities inevitably shape how supervision is implemented and perceived. In Manokwari Regency, West Papua, which comprises 18 public and private senior high schools, differences in institutional management, resource availability, and supervisory access may influence the effectiveness of academic supervision practices. Despite these contextual challenges, little is known about how physics teachers in this region perceive the role of academic supervision in supporting their efforts to enhance students' scientific literacy skills.

Therefore, this study aims to explore in depth the perspectives of physics teachers in public and private senior high schools in Manokwari Regency regarding the role of academic supervision in improving science literacy skills. Specifically, the study investigates: (1) Perceptions of academic supervision, (2) Perceptions of supervisor competence, (3) Implementation of academic supervision in educational institutions, (4) Constraints faced by physics teachers regarding science literacy skills and academic supervision. By foregrounding teachers' perspectives and situating supervision within the unique socio-geographical realities of West Papua, this study offers a novel contribution to the academic supervision literature.

The novelty of this research lies in three key aspects. First, it centers explicitly on Physics teachers' perspectives, an underrepresented viewpoint in supervision research. Second, it links academic supervision directly to the development of scientific literacy, thereby integrating instructional leadership with discipline-specific learning outcomes. Third, it situates the analysis within a remote and geographically constrained region, providing context-sensitive insights rarely captured in mainstream supervision studies. Theoretically, this study contributes to the refinement of academic supervision models by incorporating teacher-perceived effectiveness within marginalized educational contexts. Practically, it offers evidence-based recommendations for principals, supervisors, and education authorities to design supervision strategies that are relational, contextually adaptive, and oriented toward strengthening science literacy in senior high schools.

Method

This study uses a qualitative approach with a case study type. This approach was chosen to explore in depth the perceptions of Physics Science teachers towards academic supervision they experience in their respective schools. Case studies are considered appropriate because they allow researchers to understand the phenomenon as a whole through the experiences of the subjects in real settings (Yin, 2018). The subjects in this study were Physics Science teachers who taught at Senior High Schools in Manokwari Regency, West Papua, totaling 9 teachers. The determination of informants was carried out purposively, namely teachers who had experience receiving academic supervision for at least the last two years and were willing to provide information openly.

This study was conducted in selected senior high schools in Manokwari Regency and several surrounding areas in West Papua, representing diverse school characteristics in terms of institutional status (public and private), geographical location, and the availability of Physics teachers. The participating schools included SMAN 1 Manokwari, SMAN 2 Manokwari, SMAN 1 Warmare, SMAN 1 Kokas, SMAN 3 Arfai, SMA Yapis, SMA YPPK St. Arnoldus, and SMAN 1 Oransbari. These schools were purposively selected to capture

variation in contextual and institutional conditions that may influence the implementation of academic supervision.

Data were collected through semi-structured, in-depth interviews conducted directly with Physics teachers using a previously developed interview protocol. The interviews focused on teachers' experiences, perceptions, and expectations regarding the academic supervision process, particularly in relation to improving scientific literacy instruction. The data were analyzed using a combination of descriptive and analytical techniques. The descriptive analysis systematically organized the data into key themes related to teachers' perceptions of supervision practices and their perceived impact on science literacy development. Subsequently, analytical interpretation was employed to identify patterns, relationships of meaning, and both theoretical and practical implications emerging from the findings. This approach enabled the researchers to draw in-depth conclusions, connect empirical evidence with relevant theoretical frameworks, and formulate context-sensitive recommendations grounded in the realities of educational practice in West Papua (**Figure 1**).

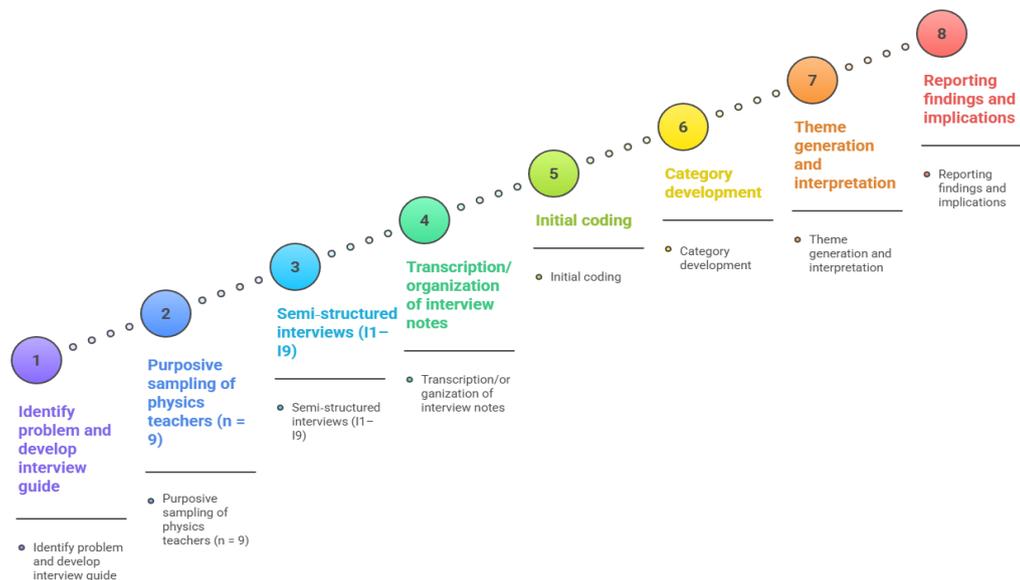


Figure 1. Research Process Flow

Results and Discussion

Finding on Physics Teachers' Perceptions, Supervisory Practices, and Challenges in Promoting Scientific Literacy

The study examined physics science teachers at 6 State senior high schools and 2 private senior high schools, including 3 government employees with work agreements (PPPK), 6 honorary teachers, 8 teachers with a bachelor's degree (S1), and 1 teacher with a master's degree (S2). On average, these educators possess over 2 years of instructional experience. This investigation effectively delineated the perceptions of physics science educators concerning the execution of academic supervision in Manokwari Regency and adjacent regencies. The five primary subjects addressed were: (1) Perceptions of academic supervision, (2) Perceptions of supervisor competence, (3) Implementation of academic supervision in educational institutions, (4) Constraints faced by physics teachers regarding science literacy skills and academic supervision, and (5) Evaluation and future expectations. Physics educators serving as informants indicated that they possess a comprehensive understanding of academic monitoring. The academic supervision they have experienced

thus far is predominantly formal, occurring once or twice per semester, and pertains to administrative matters. The supervisory technique is deemed to have inadequately addressed the instructional aspect in depth. Educators believe that supervision emphasises the evaluation of instructional materials, such as lesson plans and administrative tasks, rather than offering support to enhance pedagogical methods in the classroom.

According to the study's findings, physics educators indicated that the aim of academic supervision is to enhance a teacher's proficiency and the quality of education by offering technical support during the learning process; to elevate teacher competence in instruction; to foster teacher professionalism; to assess shortcomings in the educational process; to enhance the educational system's performance; to refine the learning process; and to ensure optimal achievement of curriculum objectives. Educators indicated that the proficiency of supervisors significantly affected their views on academic supervision. Certain educators believed that supervisors lacked adequate scientific knowledge, rendering their feedback occasionally irrelevant or inapplicable. When the supervisor lacked a background in the sciences, their feedback often remained overly generic and failed to address the specific subject matter we were instructing. This underscores the significance of aligning the supervisor's area of expertise with the field of research being overseen. The supervisor's experience and field supervision are crucial to educational quality (Kemer et al., 2019; Sheu et al., 2017).

This study's findings indicated that academic supervision activities in both public and private senior high schools commenced with document analysis (including lesson plans and other materials), followed by the principal conducting supervision utilising techniques comprising 100% class observation, 88% reflection, 11% mentoring, and 11% training, tailored to specific conditions. The predominant supervision methodologies employed are 66% scientific approach, 22% clinical approach, 11% collaborative approach, and 11% differentiation approach. Post-supervision reflection occurs through verbal discussions that include comments, enquiries, guidance, suggestions, and critiques aimed at identifying areas for enhancement and offering recommendations to elevate the quality of learning. This may also involve written corrections to teaching materials or modules observed during class sessions. Reflection is an essential element of academic supervision, as it allows educators to critically assess their teaching methods, pinpoint areas for enhancement, and pursue ongoing professional development through constructive discussions with supervisors (Pote et al., 2024; Kernberg, 2019; Rankine, 2018).

The challenges encountered by physics educators are: 1) The deficiency in literacy and numeracy among pupils presently results in a limited comprehension of mathematical ideas in physics computations. Throughout my tenure teaching physics, I have observed that students frequently struggle with calculation issues necessitating mathematical principles, such as dividing decimals, due to their inadequate comprehension of abstract subject, 2) Instructors: Effective time management is essential for preparation, but inadequate resources, including insufficient laboratory facilities, technology, and learning materials, might impede the educational experience. Educators fail to connect the material's substance with its practical application in the student's contextual surroundings. The implementation of the scientific method via scientific literacy skills remains inadequate. The interview results indicated that the information was confined to initiatives aimed at enhancing teachers' scientific literacy, without a detailed explanation of the specific difficulties hindering their scientific literacy skills.

Academic supervision is a systematic and organised coaching process conducted by the principal or supervisor to enhance teachers' professional competencies, particularly in pedagogical methods and learning management (Usman et al., 2023; Muslimin, 2020).

Academic supervision seeks to assist educators in cultivating reflective and student-centered pedagogical approaches (Glickman, et al., 2017). Effective supervision evaluates teacher performance and directs them towards achieving optimal learning quality. The application of academic supervision may be directive, collaborative, or non-directive, contingent upon the demands and preparedness of the teacher. Collaborative supervision facilitates open communication between educators and supervisors, fostering a more equitable and mutually helpful relationship.

Perception of Academic Supervision

Teachers' perceptions of academic supervision play an important role in determining the effectiveness of the supervision process itself. Teachers who have positive perceptions of supervision will be more open to input and willing to make improvements in their teaching practices. Conversely, negative perceptions can cause resistance, even rejection of the coaching process. According to Robbins & Judge (2024), perception is an individual's interpretation of a stimulus or event that can be influenced by experience, knowledge, and environmental conditions. Factors that influence teacher perceptions include the quality of interpersonal relationships with supervisors, the supervision methods used, clarity of supervision objectives, and the relevance of the input provided.

Research by Nugraha et al. (2024) emphasizes the importance of open communication and mutual trust in building positive perceptions of academic supervision. In line with Prasetya (2023) and Sujoko (2018), academic supervision reflects a supervisor's capacity to evaluate and develop teachers to improve the quality of the learning process covering learning content, syllabus and lesson plan preparation, selection of strategies/methods/techniques, use of instructional media and information technology, evaluation of processes and outcomes, and classroom action research so that it ultimately contributes positively to student learning outcomes. The basic essence of academic supervision in efforts to improve the quality of teaching and learning carried out by teachers to improve the quality of student knowledge, of course has a positive goal for improving learning activities in an educational institution (school).

Perceptions of the Supervisor's Competence

Supervision carried out using classroom observation techniques, observing the teaching and learning process in the classroom. This shows that the dominant supervision approach is the same for all subject teachers, while the conditions, needs, characteristics of teachers, and problems of each subject teacher are different. Physics science teachers during the teaching and learning process are required to apply a scientific approach, i.e. science literacy skills: understanding scientific concepts, science process competencies, the context of science and technology in everyday life, attitudes towards science, data literacy and scientific representation, critical thinking skills and decision making. A supervisor must understand this science literacy. Teachers when teaching must prepare themselves with innovative teaching materials and modern learning methods (Goldhaber, 2019; Olson, 2017).

The analysis that can be given as a solution is that the implementation of academic supervision is certainly motivated by the characteristics of teachers, teacher needs, clinical problems in a teacher's learning. The principal can apply a supervision approach and technique that can help improve, improvement and development of the teacher. The principal can form an internal supervision team consisting of professional teachers of each subject. Supervisors who do not have adequate competence as a prerequisite for implementing academic supervision; academic supervision has not been implemented effectively which is explored from two sources: First, from the supervisor; 1) limited time (many administrative tasks to be completed); 2) not yet programmed in a participatory manner; 3) lack of

supervisor understanding of the concept, theory and practice of supervision; 4) lack of supervisor scientific understanding of the substance related to the field of study taught by each teacher (Sheu et al., 2017; Rahabav, 2016). Second, from the teacher's side; 1) low commitment to quality; 2) the motivation of many teachers who work solely to pursue welfare. The effectiveness of supervision is influenced by the supervisor's capacity to understand the learning context faced by teachers, so that they can provide specific and appropriate guidance.

Implementation of Academic Supervision in Schools

Assignment of teachers as principals emphasizes that principals as learning leaders have the responsibility to assist, monitor, and evaluate teacher performance, including through supervision (Amelia et al., 2022; Rogers et al., 2018). The implementation of academic supervision is concerning the fulfillment of the workload of teachers, principals, and school supervisors that the principal is obliged to carry out academic supervision at least 2 times a year for each teacher (Amelia et al., 2022). This supervision is part of the principal's managerial duties. In line with the objectives of academic supervision by (Glickman et al., 2017): The purpose of supervision is to improve the teaching-learning process to improve the teaching-learning process. This includes improving learning planning, implementing learning activities, and evaluating learning by teachers. Lorensius et al. (2022) academic supervision aims to help teachers improve their professional abilities in designing, implementing, and assessing the learning process. Usman et al. (2023) it is intended to improve the teaching-learning situation to make it more effective and efficient. Academic supervision helps teachers to develop their abilities in achieving the educational and learning goals set for their students (Rusdiman, 2022). Supervision that is not reflective and collaborative will tend to have less impact on teacher professional development (Nugraha et al., 2024). Teachers expect a more participatory and dialogic approach, where they can share learning challenges and receive constructive feedback.

Teacher professionalism is one of the important factors in determining the quality of education, teacher professionalism needs to be continuously improved in accordance with the dynamics of needs. One effort to improve teacher professionalism is academic supervision. Academic supervision focuses on improving and strengthening teacher learning skills (Usman et al., 2023; Lorensius et al., 2022). The principal must be able to manage teacher performance in his school. In carrying out his responsibilities in managing performance, the principal contributes to improving overall teacher performance in an effort to get better results. The extent to which the principal's academic supervision affects teacher performance. The involvement of all components of education (teachers, principals, communities, and school committees) through good planning and realizing the planned education programs is very necessary, conducting evaluations and follow-ups. Academic supervision carried out by the principal has a positive and significant effect on changes in teacher performance. Teacher performance can be improved if the principal's academic supervision in the form of leadership and supervision is improved.

Supervision activities are the main tasks and functions of the principal or school supervisor, supervision activities aim to improve learning activities, improvement and development of teacher professionalism. Efforts to improve learning activities should ideally grow from the teacher themselves, not from the principal or supervisor. As experts say about academic supervision, namely coaching teacher performance in managing learning (Usman et al., 2023). According to Kholid & Rohmatika (2019), clinical supervision (developed and modified from Cogan's clinical supervision model) functions as a structured teacher-coaching process to improve teachers' performance in managing the teaching learning process, implemented through stages such as an initial meeting and planning, classroom

observation, a post-observation meeting, and follow-up. Clinical supervision is the provision of guidance and feedback to support personal, professional, and educational development within safe and appropriate practice so it functions as a structured coaching process that strengthens professionalism and helps improve ineffective teaching and learning practices (Rankine, 2018; Kernberg, 2019). Pote (2024) defines supervision as a service provided by school leaders to help teachers individually or in groups become more competent and professional, and Lorensius et al. (2022) emphasize that sustained, systematic academic supervision strengthens teachers' professional competence and can ultimately improve student learning outcomes. Academic supervision is described by Nugraha et al. (2024) as professional assistance for teachers that is carried out through a systematic cycle planning, careful classroom observation, and objective, timely feedback, so the focus is guidance for improvement rather than merely evaluation. In the same spirit, Sahudi & Ma'arif (2024) frame collaborative supervision as joint guidance and support organized in phases (planning, implementation, outcomes, feedback, and impact), ensuring supervision functions as a continuous developmental process instead of a one-off assessment.

The examination of academic supervision execution might be articulated as follows: a). The management of academic supervision is crucial for a principal or internal supervision team, encompassing three competencies: 1) devising an academic supervision program to enhance teacher professionalism, 2) executing academic supervision of teachers utilising appropriate approaches and techniques, and 3) addressing the outcomes of academic supervision to further improve teacher professionalism (Nurhadi et al., 2023); b). The execution of academic oversight, encompassing both formally arranged and informally contingent sessions; c). Academic supervision strategies and methodologies are tailored to address the challenges and requirements of educators, as well as their individual qualities (dropout/unfocused worker, analytical observer, professional); d). Collaboration among physics educators during subject teacher deliberations; e). Establishing teacher study groups/Professional Learning Communities (PLCs). f). Allocating one day exclusively for teachers' meetings to address the supervisor's proficiency in academic supervision management and the coaching and enhancement of teacher competencies. The principal must consistently oversee the instructional activities conducted by teachers in the classroom to identify the challenges encountered by both educators and students.

Constraints of Physics Science Teachers in Relation to Scientific Literacy and Academic Supervision

Some concrete steps taken by schools to improve the science literacy of Physics Science teachers include: Holding training and workshops to improve teachers' abilities in teaching science and using innovative learning methods. The provision of post-supervision training or mentoring to follow up on the recommendations given shows that teachers view supervision as a means of coaching that is ideally supportive, not just controlling. This is in line with the clinical supervision approach which emphasizes collaboration and joint reflection in an effort to improve the quality of learning (Rankine, 2018; Kernberg, 2019). Use of technology: Using technology to improve the science literacy of teachers and students, such as the use of online learning applications and digital resources. Schools support and facilitate regular meetings of the physics science subject teacher working group/teacher deliberation where teachers can share knowledge, experiences, learning resources, and discuss current science issues. Providing access to journals or science learning resources. The school through the library provides various books that can improve science literacy as a physics teacher. Every year, provision is provided to improve teachers' teaching skills, provide relevant media, and encourage teacher participation in scientific activities (Sugihartini et al., 2020; Tilstone & Upton, 2018). Buy books related to physics and nature.

Shared understanding that the learning process must be held interactively, inspiring, fun, challenging, and motivating students and when implementing academic supervision by the principal/team, teachers should translate and apply aspects of scientific literacy (adapted from PISA) in the learning process, namely: Understanding concepts, learning design, scientific problem solving, scientific data analysis, scientific communication, reflection and evaluation, learning innovation. In line with the approach used in the 2013 curriculum is the scientific approach (scientific approach) which consists of five activities (5M), namely observing, asking, experimenting, associating, and communicating. science literacy indicators can be used for Supervision as follows: Compiling lesson plan/modules that include scientific literacy (real phenomena, analytical tasks); Developing questions based on context and scientific data; Training students to read graphs and analyze experimental results; Being able to explain the relationship between scientific concepts and their social applications (Suyanto, 2018).

Physics science teachers need guidance that is not only technical, but also conceptual. Therefore, supervisors are required to have an adequate understanding of science materials and science-based learning approaches. This is in line with the view of the Rankine (2018) and Kernberg (2019) which emphasizes that supervision must encourage teachers to become lifelong learners and be able to adapt learning to developments in science and technology. In physics science learning, academic supervision has its own challenges because it requires mastery of complex scientific concepts and the application of scientific approaches in learning. Quality supervision needs to pay attention to how teachers design experiments, compile questions based on scientific literacy, and foster critical thinking skills in students.

Physics Science Teachers' Evaluation and Expectations of Academic Supervision

A number of teachers expressed their desire for academic supervision to be carried out continuously, accompanied by open dialogue and the provision of real solutions to learning problems in the classroom (Table 1). They also expect supervision to be a space for reflection, not just a performance evaluation. Supervision is an activity that is not scary and is non-judgmental. This is exacerbated by the lack of training for supervisors to carry out their roles professionally and participatively. As a result, the potential of academic supervision in supporting learning improvements has not been utilized optimally. As an effort to strengthen academic supervision in schools, it is important to understand how teachers perceive the process and benefits of supervision. Teacher perceptions are important indicators for assessing the effectiveness of supervision practices that have been carried out (Nuryani et al., 2022; Ahmad & Saefurrohman, 2020). If teachers view academic supervision as a process that supports and enriches teaching practices, then it is likely that supervision will have a significant impact on improving the quality of learning, especially in strengthening science literacy.

Table 1. Teachers' Expectations for the Future Development of Academic Supervision

Informant Code	Statement (Expectations)	Main Theme Summary
I1	"Hopefully, it can be done more often and provide convenience and help provide solutions in learning."	More frequent implementation; convenience; learning solutions
I2	"My hope is that it is done more often so that teachers also know the things that need to be fixed during learning."	More frequent implementation; identifying areas for improvement in teaching/learning
I3	"My hope is that the development of academic supervision will present innovations in new supervision techniques so that it can better help teachers in developing and improving"	Innovation in supervision techniques; strengthening teaching quality and teacher

Informant Code	Statement (Expectations)	Main Theme Summary
	the quality of learning and teacher skills and knowledge in the future. With various techniques, academic supervision can be carried out according to the expected target.”	competence; targeted supervision
I4	“Continue to be implemented and even must be developed again. So that teachers' academic abilities and teaching abilities continue to develop in accordance with the times.”	Continuity and further development; adaptability to changing times
I5	“Can provide encouragement to always develop in line with the times and technology.”	Motivation to grow; alignment with technological change
I6	“Supervision is more intensive, routinely scheduled, and involves a more personal approach and is based on teacher needs.”	More intensive and routine; personalized approach; needs-based supervision
I7	“Some hopes for the development of academic supervision to be more effective in the future, Use of technology: to increase the efficiency and effectiveness of supervision, such as the use of online applications for monitoring and evaluation.”	Technology use to improve efficiency and effectiveness; online monitoring and evaluation
I8	“Ongoing evaluation and monitoring: to ensure that supervision remains effective and relevant to the needs of the school.”	Continuous evaluation and monitoring; maintaining relevance and effectiveness
I9	“By developing more effective academic supervision, schools can improve the quality of learning and teaching, as well as improve students' science literacy. I hope that supervision can be a discussion space that helps us develop, not just assess. There is real and regular follow-up.”	Improving teaching/learning quality and science literacy; supervision as a developmental dialogue; real, regular follow-up

This study provides significant theoretical and practical implications for strengthening academic supervision as a strategic mechanism to enhance scientific literacy in higher education, particularly in geographically diverse and resource-constrained contexts in West Papua. By foregrounding Physics teachers' perspectives, the findings highlight the necessity of shifting supervision from a predominantly administrative and document-oriented practice toward a more pedagogically focused, collaborative, and discipline-relevant approach. The study underscores the importance of aligning supervisors' subject-matter expertise with the teachers they supervise to ensure meaningful and actionable feedback. Furthermore, it emphasizes that effective supervision must integrate reflective dialogue, contextual support, and targeted professional development to address challenges related to students' literacy and numeracy skills, limited facilities, and inquiry-based instruction. For policymakers and school leaders, these insights offer evidence-based guidance for designing supervision models that are not only procedurally compliant but also transformative in improving instructional quality and advancing students' scientific literacy outcomes in secondary schools.

Conclusion

The study finds that physics Science teachers in West Papua generally understand the purpose of academic supervision, but often experience it as administrative and not deeply supportive of classroom learning improvement. A major barrier is supervisors' competence that is not aligned with the Physics Science field, which weakens the effectiveness of supervision. Supervision practices tend to prioritize document review and formal classroom observation conducted once or twice per semester, with limited in-depth pedagogical guidance specifically targeting the development of scientific literacy skills. Teachers emphasized that supervisory competence, particularly subject-matter alignment and the ability to provide contextual, discipline-relevant feedback is a decisive factor in determining the perceived usefulness of supervision. In several cases, the lack of a science background

among supervisors reduced the relevance of feedback for improving Physics instruction and literacy-oriented practices. Even so, teachers strongly expect supervision to function as a collaborative, reflective, and continuous coaching process with space for dialogue and real instructional support. The findings stress the urgency of a humanistic and contextual supervision approach, especially in West Papua where geographical constraints and limited resources shape implementation. Meaningful supervision is seen as improving not only teaching quality but also teacher motivation and professional growth. Therefore, capacity building for principals and supervisors, teachers' active reflective engagement, and contextual training by the education office are needed. Sustainability should be ensured through a structured, periodic follow-up system, and future studies should expand to other regions using mixed methods. Future research should expand this inquiry by employing mixed-method or longitudinal designs to examine the measurable impact of supervision models on students' scientific literacy achievement over time. Comparative studies across different provinces or remote regions would also provide broader insights into how geographical and institutional factors shape supervision effectiveness. Additionally, intervention-based research testing subject-specific and literacy-focused supervision frameworks could contribute to the development of more adaptive and evidence-based academic supervision models for science education in diverse educational contexts.

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