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Everyday Science in Action: Training on Simple Research for Enhancing Scientific Literacy among Science Teachers at MA Salafiyah Kajen Pati

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ABSTRACT

Scientific literacy is essential for both teachers and students to understand natural phenomena and make informed decisions in daily life. However, many teachers face challenges in implementing research-based approaches to enhance scientific literacy in their classrooms. This community service project aimed to provide training on simple research methods for improving scientific literacy to science, mathematics, and geography teachers at MA Salafiyah Kajen Pati. Conducted on November 19, 2025, the training involved 17 teachers and introduced the PISA (Programme for International Student Assessment) framework for scientific literacy, encompassing four key components: science content knowledge, science processes, application contexts, and scientific attitudes. The training emphasized the concept of "everyday science" - recognizing that scientific principles are embedded in common daily activities such as cooking, walking, bathing, and using technology. Teachers were introduced to simple research approaches using everyday contexts to strengthen students' scientific literacy, covering the four aspects of scientific literacy: science as a body of knowledge, as an investigative tool, as a way of thinking, and as interaction between science, technology, environment, and society. The training demonstrated how teachers can utilize familiar daily activities as contexts for developing students' scientific competencies including identifying scientific questions, collecting evidence, drawing conclusions, and communicating findings. Participants engaged in discussions about implementing context-based learning in their subject areas and designing simple research activities that connect scientific concepts to students' lived experiences. The program successfully equipped teachers with frameworks and strategies for conducting simple research to enhance scientific literacy, emphasizing that science education should extend beyond textbooks and laboratories to encompass real-world applications.

Keywords:
Scientific Literacy; Teacher Training; Simple Research; Context-Based Learning; PISA Framework

Introduction

Scientific literacy has become increasingly recognized as a fundamental competency for navigating modern society, where scientific and technological developments continuously shape daily life and require informed decision-making (OECD, 2017). The Organisation for Economic Co-operation and Development (OECD) through its Programme for International Student Assessment (PISA) defines scientific literacy as the ability to engage with science-related issues and with the ideas of science as a reflective citizen, encompassing the competencies to explain phenomena scientifically, evaluate and design scientific inquiry, and interpret data and evidence scientifically (OECD, 2017).

Teachers play a crucial role in developing students' scientific literacy, yet many educators face challenges in moving beyond traditional content-focused instruction to approaches that emphasize scientific inquiry, real-world applications, and critical thinking (Holbrook & Rannikmäe, 2009). Effective scientific literacy instruction requires teachers to understand not only scientific content but also how to engage students in scientific practices and help them recognize science's relevance to their daily lives (Glynn & Winter, 2004). Professional development programs that support teachers in developing these competencies are essential for improving science education quality.

One effective approach to enhancing scientific literacy is context-based learning, which situates scientific concepts within familiar, real-world contexts that are meaningful to learners (Gilbert, 2006). Context-based learning connects science to everyday life, societal issues, and technological applications, making learning more relevant and engaging for students (Parchmann et al., 2006). Research has demonstrated that when science instruction begins with contexts from students' daily experiences, students show improved motivation, engagement, and conceptual understanding (Glynn & Winter, 2004; Gungor et al., 2023).

The concept of "everyday science" recognizes that scientific principles continuously operate in routine activities, from cooking and transportation to communication and personal hygiene (Glynn & Winter, 2004). When teachers help students identify and investigate the science embedded in these familiar activities, students develop deeper understanding of scientific concepts while recognizing science's pervasive role in their lives. This approach transforms science from an abstract academic subject into a tool for understanding and engaging with the world.

Simple research activities provide valuable opportunities for developing scientific literacy by engaging students in authentic scientific practices. Through designing investigations, collecting and analyzing data, drawing evidence-based conclusions, and communicating findings, students develop the competencies central to scientific literacy (Holbrook & Rannikmäe, 2009). When these research activities are grounded in everyday contexts, they become more accessible and meaningful to students while maintaining scientific rigor.

The PISA framework provides a comprehensive structure for understanding and developing scientific literacy, consisting of four interrelated components (OECD, 2017). First, science content knowledge includes understanding of facts, concepts, and theories across physical, living, and Earth and space systems. Second, science competencies or processes involve the ability to explain phenomena scientifically, evaluate and design scientific inquiry, and interpret data and evidence scientifically. Third, application contexts encompass personal, local/national, and global situations where scientific understanding is relevant. Fourth, attitudes include interest in science, valuing scientific approaches to enquiry, and environmental awareness.

Complementing the PISA framework, scientific literacy can be understood through four aspects that highlight different dimensions of scientific understanding (Holbrook & Rannikmäe, 2009). Science as a body of knowledge encompasses the accumulated facts, concepts, principles, laws, hypotheses, theories, and models that constitute scientific understanding. Science as an investigative tool emphasizes the processes of generating, testing, and clarifying ideas through systematic collection and analysis of evidence. Science as a way of thinking involves reasoning, reflection, and understanding how scientific knowledge is developed and validated. Finally, the interaction of science, environment, technology, and society represents how scientific developments impact and are impacted by societal contexts.

In Indonesia, enhancing scientific literacy has become an educational priority, particularly in light of international assessment results highlighting areas for improvement. Teachers need support in implementing approaches that develop students' scientific literacy rather than focusing solely on content memorization (Gungor et al., 2023). Professional development programs that introduce teachers to frameworks like PISA and provide practical strategies for context-based, inquiry-oriented instruction can significantly impact classroom practice.

Islamic educational institutions, such as madrasah, have particular opportunities to integrate scientific literacy development with their educational missions. Science education in these contexts can demonstrate compatibility between scientific inquiry and Islamic values while preparing students with competencies needed for success in further education and informed citizenship (Suwono et al., 2022).

This community service initiative, conducted by the Physics Department of Universitas Islam Negeri Walisongo Semarang, aimed to provide professional development for science, mathematics, and geography teachers at MA Salafiyah Kajen Pati. The training focused on simple research approaches using everyday contexts to enhance students' scientific literacy, introducing teachers to the PISA framework and practical strategies for implementing context-based, inquiry-oriented instruction in their classrooms.

Methods

The community service training program was implemented through three main stages: preparation, implementation, and evaluation.

Stage I: Preparation

The preparation phase involved collaboration between the Physics Department team of Universitas Islam Negeri Walisongo Semarang and the administration of MA Salafiyah Kajen Pati. Initial discussions with school leadership identified the need for professional development focused on approaches to enhance students' scientific literacy. Teachers expressed interest in learning about research-based methods that could be implemented within their existing curriculum and resource constraints.

Based on these discussions, the training curriculum was designed to introduce the PISA framework for scientific literacy and demonstrate how simple research activities using everyday contexts can develop students' scientific competencies. The training aimed to equip teachers with both conceptual frameworks and practical strategies they could immediately apply in their teaching.

Training materials were prepared including presentation slides explaining the PISA scientific literacy framework, the concept of everyday science, and examples of how common activities involve scientific principles. The presentation was structured to cover the importance of scientific literacy, the PISA definition and framework, everyday science examples across various content domains, the four aspects of scientific literacy, and implications for designing learning activities.

The resource team consisted of Dr. Susilawati, Irman Said Prastyo, Dr. Hamdan Hadi Kusuma, Ulil Albab, and Ulya 'Uyun Latifah from the Physics Department, Faculty of Science and Technology. Team members divided responsibilities for different components of the training based on their expertise. Coordination with school administrators ensured appropriate scheduling, facility arrangements, and teacher participation.

Stage II: Implementation

The training program was conducted on Wednesday, November 19, 2025, at MA Salafiyah Kajen Pati. Seventeen teachers participated in the training, including science, mathematics, and geography teachers who teach students across different grade levels.

The program began with an introduction emphasizing the importance of scientific literacy in contemporary society. Four key rationales were presented: (1) daily life is filled with scientific phenomena requiring understanding, (2) many everyday decisions require scientific knowledge as their foundation, (3) scientific literacy helps minimize susceptibility to hoaxes and misconceptions, and (4) developing scientific literacy prepares a smart and critical generation for future challenges toward 2030. The PISA definition of scientific literacy was introduced as the ability to use scientific knowledge, identify questions, and draw conclusions based on evidence to understand nature and make decisions about human activities affecting nature. The presentation emphasized that this definition extends beyond content knowledge to encompass scientific competencies, contexts of application, and scientific attitudes.

Teachers were introduced to the four components of the PISA scientific literacy framework. Science content knowledge encompasses understanding across various domains. Science processes include competencies in explaining phenomena scientifically, evaluating and designing scientific inquiry, and interpreting data and evidence scientifically. Application contexts span personal, local/national, and global situations where scientific understanding is relevant. Scientific attitudes include curiosity, critical thinking, and evidence-based reasoning.

The concept of "everyday science" was presented as central to making science relevant and accessible. Examples demonstrated how science is embedded in common daily activities including cooking (chemical reactions, heat transfer, phase changes), walking (forces, motion, energy transformation), bathing (properties of matter, temperature effects), fueling vehicles (combustion, energy conversion), using fans (electrical energy, rotational motion), drying clothes (evaporation, energy transfer), observing rainbows (light properties, refraction), and using mobile phones (electromagnetic principles, digital technology). This presentation emphasized that science is not limited to microscopes and laboratories but is fundamentally integrated into life itself.

The training detailed the PISA framework's three main assessment components. For science processes, teachers learned about competencies including identifying scientific questions that can be

answered through inquiry, identifying evidence needed in scientific investigations, drawing and evaluating conclusions by connecting relevant evidence, communicating conclusions accurately based on valid evidence, and demonstrating use of concepts in situations different from those studied.

For science content, thirteen major themes were presented: (1) structure and properties of matter, (2) atmospheric changes, (3) physical and chemical changes, (4) energy transformation, (5) forces and motion, (6) form and function, (7) biology and humans, (8) physiological changes, (9) biodiversity, (10) genetic control, (11) ecosystems, (12) Earth and universe, and (13) geological changes. Teachers discussed how these themes appear in their respective subject areas and everyday contexts.

For application contexts, the presentation emphasized that scientific literacy requires applying understanding in daily life rather than limiting science to classroom materials or laboratory settings. Three main application areas were presented: (1) life and health, (2) Earth and environment, and (3) technology. Teachers considered how their curriculum topics connect to these application areas.

The four aspects of scientific literacy were explored in depth. Science as a body of knowledge encompasses facts, concepts, principles, laws, hypotheses, theories, and models, involving recall and application of knowledge. Science as an investigative tool involves generating, testing, and clarifying ideas through collecting scientific evidence. Science as a way of thinking includes reasoning, reflection, and understanding how scientific inquiry works. The interaction of science, environment, technology, and society represents implementation of science and technology in societal contexts and their mutual impacts.

Visual examples were presented to help teachers recognize each aspect. Teachers examined scenarios illustrating science as a way of thinking (analyzing everyday phenomena scientifically), science as an investigative tool (designing simple investigations), science as a body of knowledge (applying scientific concepts), and the interaction of science, technology, and society (considering impacts of scientific developments).

Discussions focused on how teachers could design simple research activities that develop scientific literacy. Teachers considered how to use everyday contexts as starting points for investigations, how to engage students in authentic scientific practices, and how to help students recognize connections between scientific concepts and real-world applications. Examples were discussed of simple research activities appropriate for different subject areas and grade levels.

Teachers shared ideas for potential research activities in their own teaching contexts. Science teachers discussed investigations related to local environmental issues, food chemistry, or energy efficiency. Mathematics teachers considered how data collection and analysis in everyday contexts could develop both mathematical and scientific competencies. Geography teachers explored how local geographical phenomena could serve as contexts for scientific investigation.

The presentation emphasized developing scientific attitudes including curiosity (encouraging students to ask questions about everyday observations), critical thinking (evaluating claims and seeking evidence), and evidence-based reasoning (supporting conclusions with data). Teachers discussed strategies for fostering these attitudes in their classrooms.

The training concluded with discussion of practical implementation considerations including working within time and resource constraints, aligning everyday science approaches with curriculum requirements, assessing students' developing scientific literacy, and maintaining scientific rigor while using familiar contexts. Teachers appreciated the frameworks and examples provided and expressed interest in ongoing support as they implement these approaches.

Stage III: Evaluation

The evaluation phase gathered feedback from participating teachers regarding the training's relevance and usefulness. Teachers completed brief feedback forms assessing the clarity of presentations, relevance to their teaching practice, and likelihood of implementing learned approaches.

Informal discussions with participants provided insights into which concepts and strategies resonated most strongly and what additional support teachers might need for implementation. Teachers expressed particular interest in receiving example lesson plans or activity guides demonstrating how to structure simple research activities using everyday contexts.

School administrators provided feedback on how the training aligned with school goals and suggestions for potential follow-up activities. This feedback will inform planning for possible continued collaboration and support.

Results and Discussions

The training program successfully introduced 17 science (Figure 1), mathematics, and geography teachers from MA Salafiyah Kajen Pati to frameworks and strategies for using simple research to enhance students' scientific literacy. Teachers engaged actively with the PISA framework and everyday science concepts, discussing applications to their own teaching contexts.

Figure 1. The training program

Understanding Scientific Literacy Framework

Through the training, teachers developed understanding of scientific literacy as defined by PISA, extending beyond content knowledge to encompass scientific competencies, application contexts, and attitudes. Many teachers reflected that their prior teaching had focused primarily on content coverage with limited emphasis on developing students' abilities to explain phenomena scientifically, design investigations, or interpret evidence. The PISA framework provided a more comprehensive vision of science education goals.

Teachers particularly appreciated the explicit presentation of science competencies including identifying scientific questions, collecting and evaluating evidence, drawing conclusions, communicating findings, and applying concepts in new situations. Several teachers noted that these competencies align with inquiry-based approaches they had heard about but had lacked clear frameworks for implementing. The PISA structure provided concrete guidance for what scientific practices to develop through instruction.

The presentation of application contexts - personal, local/national, and global - helped teachers recognize opportunities to connect their subject matter to relevant situations. Teachers discussed how

their curriculum topics could be framed within these contexts to increase relevance and engagement. For example, biology topics could connect to personal health decisions, environmental science could address local ecological issues, and physics could examine technology students use daily.

Understanding scientific attitudes as integral to scientific literacy resonated with teachers' goals of developing students who are curious, critical thinkers. Teachers discussed how traditional instruction often neglects attitudinal outcomes in favor of content coverage, and they expressed interest in strategies for explicitly fostering scientific curiosity and evidence-based reasoning.

Everyday Science as Educational Approach

The concept of everyday science provided teachers with a practical approach for making science more relevant and accessible. The examples of cooking, walking, bathing, transportation, and technology use demonstrated how scientific principles operate continuously in familiar activities. Teachers recognized that highlighting these connections could help students see science not as remote academic knowledge but as understanding of phenomena they experience daily.

Teachers from different subject areas identified opportunities to use everyday contexts in their teaching. Science teachers discussed how cooking could serve as a context for teaching chemical reactions, solutions, and energy transfer. Mathematics teachers considered how everyday measurement situations - cooking recipes, travel distances, financial calculations - could develop both mathematical skills and scientific data analysis competencies. Geography teachers recognized how local weather patterns, land formations, and environmental changes provide contexts for scientific investigation.

The everyday science approach aligns with research demonstrating that context-based learning improves student motivation and engagement by connecting scientific concepts to familiar situations (Glynn & Winter, 2004; Gungor et al., 2023). When science begins with phenomena students have experienced, abstract concepts become more concrete and meaningful. Teachers expressed that everyday contexts could reduce science anxiety among students who find traditional academic science intimidating.

Several teachers noted connections between the everyday science approach and Islamic principles of observing and reflecting on creation. They recognized that helping students see scientific principles in daily life could complement religious education's emphasis on contemplating natural phenomena as signs of divine wisdom. This integration of scientific and spiritual perspectives enhances the relevance of science education in Islamic school contexts (Suwono et al., 2022).

Simple Research for Scientific Literacy

Teachers engaged enthusiastically (Figure 2) with the idea of using simple research activities to develop scientific literacy. The presentation of science as an investigative tool and science as a way of thinking helped teachers understand research not merely as advanced academic activity but as fundamental to scientific literacy. Simple investigations using everyday contexts provide accessible entry points for developing students' scientific competencies.

Teachers discussed how simple research activities could engage students in authentic scientific practices including formulating questions, designing investigations, collecting data, analyzing results, drawing conclusions, and communicating findings. These practices directly develop the PISA competencies of explaining phenomena, designing and evaluating inquiry, and interpreting evidence. When grounded in everyday contexts, such activities become more accessible while maintaining scientific rigor.

Examples shared during discussions illustrated possibilities across subject areas. A science teacher described having students investigate factors affecting how quickly ice melts - a familiar phenomenon that could develop understanding of heat transfer, experimental design, and data analysis. A mathematics teacher suggested having students collect and analyze data on classroom energy use to explore both mathematical concepts and environmental applications. A geography teacher proposed investigating soil properties in different locations around the school to connect to curriculum content on Earth materials.

Teachers recognized that simple research activities need not require extensive equipment or resources. Using everyday materials and phenomena makes investigations feasible within typical school constraints. This practicality increases likelihood of implementation and helps teachers move from viewing inquiry as supplementary enrichment to seeing it as integral to regular instruction.

Figure 2. Teachers engaged enthusiastically

The Four Aspects of Scientific Literacy

The presentation of the four aspects of scientific literacy - science as body of knowledge, as investigative tool, as way of thinking, and as interaction with society - provided teachers with multiple perspectives on what students should learn. This framework helps teachers move beyond viewing science education solely as content transmission to recognizing the importance of scientific practices, reasoning, and societal applications.

Understanding science as a body of knowledge remains important, as students need factual and conceptual understanding to apply scientifically. However, teachers recognized that this knowledge becomes more meaningful when developed through investigation (science as tool) and applied to real contexts (interaction with society). Science as a way of thinking emphasizes that students should not merely accept scientific claims but understand how evidence supports conclusions and develop habits of critical evaluation.

Teachers discussed how lesson design could incorporate multiple aspects. For example, a unit on water quality could develop content knowledge about properties of water and dissolved substances (body of knowledge), engage students in testing local water samples (investigative tool), have students analyze and interpret results critically (way of thinking), and connect findings to community health and environmental policy (interaction with society). This integrated approach develops scientific literacy more comprehensively than focusing on any single aspect.

Challenges and Implementation Considerations

Teachers identified several challenges they anticipate in implementing everyday science and simple research approaches. Time constraints are significant, as curriculum coverage requirements often leave little room for extended investigations. Teachers expressed need for strategies to integrate everyday contexts and research activities efficiently within existing curriculum rather than viewing them as additions to already-packed schedules.

Assessment presents another challenge. While traditional tests measure content knowledge effectively, assessing scientific competencies like designing investigations or interpreting evidence requires different approaches. Teachers requested guidance on formative and summative assessment strategies aligned with scientific literacy goals.

Resource limitations affect some schools more than others. While everyday contexts and simple investigations minimize equipment requirements, some activities still require materials not always

available. Teachers discussed sharing resources and strategies for adapting activities to available materials.

Teacher confidence varies in implementing inquiry-based approaches. Some teachers feel comfortable facilitating student investigations, while others worry about maintaining classroom management when students work more independently or concern that they may not be able to answer all questions students raise. Teachers expressed interest in ongoing professional development and peer support as they develop these competencies.

Despite challenges, teachers expressed strong interest in implementing learned approaches. They recognized that everyday science and simple research activities could increase student engagement and develop competencies increasingly important for success beyond school. The frameworks and examples provided foundation for teachers to begin implementation while recognizing that developing expertise requires ongoing practice and support.

Implications for Science Education

The training's success in introducing teachers to scientific literacy frameworks and everyday science approaches suggests several implications for ongoing professional development and science education improvement. First, teachers benefit from explicit frameworks like PISA that articulate comprehensive goals for science education beyond content coverage. Such frameworks help teachers understand what scientific literacy entails and how their instruction can develop it.

Second, everyday contexts provide powerful tools for making science relevant and accessible. Professional development should help teachers recognize and utilize the rich scientific content available in familiar phenomena. When science instruction begins with everyday experiences, students are more likely to engage and recognize science's relevance to their lives.

Third, simple research activities offer practical means for developing scientific competencies even within typical school constraints. Teachers need support in designing, implementing, and assessing such activities. Example lesson plans, activity guides, and peer collaboration could help teachers develop competence and confidence in inquiry-based instruction.

Fourth, ongoing support is essential for teachers to successfully implement new approaches. Single training sessions raise awareness and introduce concepts, but sustained improvement requires continued professional development, peer collaboration, and access to resources. Schools and universities could partner in providing ongoing support through follow-up workshops, learning communities, and shared resources.

Finally, aligning science education with scientific literacy goals requires systemic support including curriculum frameworks that prioritize competencies alongside content, assessment systems that evaluate scientific thinking and practices, and resource allocation for professional development. Individual teacher efforts, while valuable, are enhanced when embedded in supportive educational systems.

Conclusion

This community service training successfully introduced 17 science, mathematics, and geography teachers from MA Salafiyah Kajen Pati to frameworks and strategies for using simple research with everyday contexts to enhance students' scientific literacy. Teachers learned about the PISA framework including its four components (content knowledge, competencies, contexts, and attitudes) and the four aspects of scientific literacy (science as body of knowledge, investigative tool, way of thinking, and interaction with society). The training demonstrated how everyday science provides accessible contexts for developing scientific understanding and competencies, and how simple research activities can engage students in authentic scientific practices. Teachers expressed strong interest in implementing these approaches and identified both opportunities and challenges for doing so within their teaching contexts, recognizing the need for ongoing support as they develop expertise in scientific literacy instruction.

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Conflicts of Interest

The authors affirm that they have no conflicts of interest.

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