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Empowering Scientific Inquiry Literacy Through SIDILAN: A Dissemination Program for Elementary School Teachers

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ABSTRACT

Background: The lack of science inquiry literacy among elementary school teachers is a crucial issue affecting the quality of science education. This condition is caused by various factors, including low teacher LIS competency, inadequate facilities, and a lack of learning media that support inquiry learning for students' diverse learning styles. To address this, training is needed that can provide teachers with opportunities to design inquiry learning based on students' learning styles.
Aims and Method: This community services program aimed to enhance teachers' Scientific Inquiry Literacy (SIL) through the dissemination of SIDILAN using the Interactive Lecture Demonstration method.
Results: The pre-posttest results showed a high average N-Gain (0.76), categorized as High. 13 teachers who were drilled using the SIDILAN application in their lessons experienced an increase in SIL knowledge, categorized as High. Two teachers also experienced an increase in SIL knowledge, categorized as Medium. . There has been an increase in teachers' knowledge about SIL, student learning styles, the relationship between SIL and learning styles, and scientific inquiry learning designs that facilitate various student learning styles. Teachers reported SIDILAN as user-friendly, effective in identifying student learning styles, useful for instructional planning. and improving inquiry skills so that they could achieve science with good inquiry.

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1. Introduction

Elementary school teachers' science inquiry literacy emphasizes their ability to design and teach science materials in elementary schools in accordance with the nature of science, namely discovery. Science inquiry literacy for elementary school teachers is crucial in preparing inquiry learning to facilitate students' understanding of scientific concepts (Harefa, 2023). The

application of inquiry can improve scientific literacy and equip students with essential skills to face the challenges of globalization, including critical thinking and problem-solving. Inquiry learning focuses on student engagement by facilitating students to explore, investigate, and effectively communicate scientific concepts (Harefa, 2023). Furthermore, elementary school teachers who implement inquiry learning help students improve their scientific skills, attitudes, and scientific processes, which are essential components of scientific literacy (Gultom & Alwi, 2024). Furthermore, the use of inquiry in science learning can also improve students' cognitive learning outcomes (Atmojo *et al.,* 2024). Therefore, it can be said that integrating inquiry learning into elementary school science education supports a learning environment that motivates students' active engagement in discovering scientific concepts and fosters a deeper understanding of scientific principles.

Research shows that teachers' science inquiry skills across various categories generally fall below 50%, particularly in the planning and implementation of inquiry (Rahayu *et al.,* 2022; Anam *et al.,* 2023). Most teachers stated they desired to develop inquiry skills in their learning, but lacked adequate facilities and resources to do so (Rahayu *et al.,* 2022). Furthermore, the lack of scientific inquiry training to enhance teachers' knowledge of inquiry hinders their ability to improve their inquiry literacy. External factors such as time constraints and an excessive focus on final exams make it difficult for teachers to implement inquiry-based learning (Baroudi & Rodjan Helder, 2021). Internal factors also play a significant role in this regard, including low self-confidence and a lack of teacher preparation for conducting inquiry-based activities in the classroom, resulting in teachers being less enthusiastic about inquiry-based teaching (Rude, 2025).

Teachers face high workloads and a lack of ongoing professional training. Many teachers are unfamiliar with inquiry-based learning approaches and the digital technologies that can support them (Ali & Ullah, 2021; Adrian, 2019).
Based on data, most teachers have good educational backgrounds, but they often lack ongoing training in the use of technology and interactive learning media (Yuberti *et al.,* 2024; Wibowo *et al.,* 2022). The use of learning media by science teachers in Garut is generally still simple, such as textbooks and whiteboards. Although some have tried using digital media, limited facilities and a lack of training make implementation less than optimal. More interactive, technology-based learning media are still rarely used, resulting in teachers being less engaged in dynamic and engaging learning processes (Rosyida & Prahani, 2025; Pan, 2022). Many teachers are unfamiliar with scientific inquiry-based learning approaches that emphasize exploration, experimentation, and scientific problem-solving. This is due to a lack of understanding and skills in implementing learning methods that support the development of SIL. Elementary school teachers in Garut face challenges in improving scientific inquiry literacy (SIL) (Schwartz *et al.,* 2023; Antonio & Prudente; 2024).

The low SIL of teachers in Garut may be due to several factors, including a lack of understanding of the importance of scientific literacy in everyday learning contexts (Kumar *et al.,* 2024; Rudolph, 2024). Many teachers still rely on traditional teaching methods that prioritize memorization over conceptual understanding and practical application (Mina *et al.,* 2024; Aisah *et al.,* 2024). This results in teachers being less involved in the learning process, which emphasizes exploration, experimentation, and scientific problem-solving (Wibowo, 2021; Astutik *et al.,* 2025). Many teachers still use conventional learning methods that are less effective in developing teachers' SIL (Wibowo *et al.,* 2024a; Wibowo *et al.,* 2024b). Furthermore, the lack of training and ongoing professional development also hinders teachers from improving their competencies (Supriyatman, 2024). The low SIL in Garut significantly impacts the quality of education and the nation's competitiveness. This will certainly hinder them in facing the challenges of globalization and innovation 4.0 (Yanti *et al.,* 2025).

Interviews with elementary school teachers in Garut revealed several significant challenges in implementing SIL, including the difficulty in determining appropriate learning styles and media for all students with varying learning tendencies. Difficulties in identifying learning styles and selecting appropriate media and teaching techniques are inhibiting factors in implementing inquiry learning in science. Furthermore, the limited availability of resources on learning style detection is further reinforced by a survey conducted in 15 schools in Garut, Indonesia, which revealed limited applications for determining student learning styles and the use of digital media to support science learning. The interview results are presented in Table 1.

Tabel 1. Teachers' Activeness in Detecting Learning Styles and Using Digital Media

% Teacher	Determining learning styles	Digital Media Usage
Do	20%	10%
Not Doing	80%	90%

Based on Table 1. it was found that 20% of elementary school teachers actively detect students' learning styles. Furthermore, 10% of elementary school teachers use applications to support student learning, while the rest only use manual detection using questionnaires and manual processing. Therefore, it can be concluded that many science teachers in the regencies/cities of West Java Province still do not use applications to detect students' learning styles to assist in decision-making when preparing the teaching and learning process.

Then there are also several priority issues faced by partners in community service, namely: a) Low Scientific Inquiry Literacy, where teachers lack understanding and skills in implementing scientific inquiry-oriented learning, are less able to guide students effectively in formulating research questions, designing experiments, collecting and analyzing data, and drawing conclusions based on evidence; b) Teachers do not fully understand the concepts and principles of Differential

Learning, Teachers have difficulty identifying individual differences in learning, adapting learning materials and methods, and creating an inclusive learning environment that accommodates diverse student learning needs, such as student learning styles; c) Teachers are less skilled in utilizing digital media such as SIDILAN. As a result, the potential of SIDILAN as an interesting and interactive learning medium has not been optimally utilized; d) Science teachers have not been able to integrate SIDILAN synergistically into their learning. They do not yet understand how these two approaches can complement and strengthen each other in improving teachers' critical thinking skills. This has an impact on low scientific inquiry literacy, critical, logical, and analytical thinking skills, as well as poor problem-solving and evidence-based decision-making abilities.

Based on the above description, the priority of this community service initiative is the low level of scientific inquiry literacy (SII) among teachers in science learning. This ability is crucial for teachers to develop critical, logical, and creative thinking, as well as to deeply understand science concepts. The low level of teachers' SII directly impacts the quality of the learning they provide. This problem is exacerbated by teachers' limited understanding and skills in implementing SIDILAN. SIDILAN is an approach that recognizes and responds to individual differences in teacher learning. Teachers need to be able to identify diverse learning styles, adapt learning materials and methods, and create an inclusive learning environment. Furthermore, the use of interactive digital modules (SIDILAN) (Setyabudi *et al.,* 2024; Wibowo *et al.,* 2024d) in science learning is also still low. SIDILAN, in fact, has great potential to increase teacher interest and motivation in learning (Wibowo *et al,* 2024c), as well as facilitate the understanding of abstract science concepts. Teachers need to have the skills to select, use, and develop SIDILAN (Scientific Inquiry Literacy) relevant to the learning materials and their characteristics. Teachers' limited understanding and skills in utilizing SIDILAN mean that the potential of this learning medium cannot be optimally utilized. As a result, science learning becomes less engaging and less effective in developing teachers' scientific inquiry skillsThis aligns with research that suggests training and collaboration between teachers can help bridge the gap in knowledge and implementation of inquiry in classroom teaching (Kwak, 2011). Therefore, training was conducted for elementary school teachers using applications that can facilitate the implementation of science inquiry. The purpose of this community service is to improve the quality of science learning at the school level through the dissemination and implementation of SIDILAN.

2. Methods

To address the aforementioned science learning issues in elementary schools, the PKM Program, in response to the challenges identified by our partners, proposes several solutions:

a. Empowering Science Teachers Through SIDILAN: We offer training in creating Interactive Digital Science Modules, equipping teachers with the skills to develop engaging and effective learning media for their science classes.
b. Collaboratively Integrating SIDILAN Production for Science Education: To provide additional support, we assist in producing high-quality SIDILAN media specifically designed for science learning.
c. Fostering Creative Thinking Skills: Recognizing the importance of critical thinking, we aim to design and implement SIDILAN for Scientific Inquiry Literacy Instruments (SIL) to assess and promote these skills in teachers.
d. Integrating SIL into Integrated SIDILAN: Building on SIDILAN training, we offer mentoring and workshops focused on designing and using SIDILAN materials that explicitly nurture and assess SIL in line with the demands of the Industrial Revolution 4.0.

Table 2 presents a more detailed overview of the solutions offered based on the identified problems.

Tabel 2. Solutions Offered in Partner Problem-Solving Through SIDILAN for SIL Dissemination

Diagnosis	Problem	Objective	The solutions offered
Guru belum sepenuhnya ma Teachers are not yet fully capable of developing online learning media.	Low ability and skills in using virtual media for learning	Improving the abilities and skills of science teachers in developing SIDILAN for science learning.	Training using the Interactive Lecture Demonstration method in the form of practice using SIDILAN
Teachers keep unused simulations as interesting learning media for Teachers	Low knowledge and skills in using SIDILAN media to develop learning media	Improving the abilities and skills of science teachers in utilizing SIDILAN media in creating learning	Training with the Interactive Lecture Demonstration method. Practical use of computers as a learning medium so that it can produce a learning medium that

Diagnosis	Problem	Objective	The solutions offered
		media.	can be used.
Low Scientific Inquiry Literacy (SIL) of Teachers	Low SIL skills in the era of the industrial revolution 4.0	Improving the skills of SIL Science students in facing the industrial revolution 4.0	Training with Interactive Lecture Demonstration method

Based on Table 2, it was found that Community Service Program integrated SIDILAN Training for Teachers as a Learning Application for the Industrial Revolution. Community Service Program was implemented through training using the Interactive Lecture Demonstration (ILD) method, accompanied by practical training using SIDILAN media. The PKM target achievement indicator was that 80% of teachers understood how to use SIDILAN to improve the quality and quantity of online science learning. This Community Service activity was packaged using a workshop approach with ILD. Activities were carried out using lectures, discussions, and exercises. The steps for implementing this service activity were as follows:

a. Step 1: Training participants, through dissemination conducted by lecturers, were provided with SIDILAN materials: https://phylament.zizicorp.my.id/quiz.eduphysPKM-unj.ac.id/file/D_/Website/1%20halaman/www.educationplanner.org/students/self-assessments/learning-styles-quiz.html
b. Step 2: Participants were given the opportunity to discuss the materials provided. Questions and answers were provided to clarify any remaining doubts.
c. Step 3: Participants practiced developing media for science learning.
d. Step 4: Participants were given a guide to developing media for science learning.
e. Step 5: The results of the media development work for learning were collected and analyzed for input and further improvement.

The target group for this Community Service (PKM) activity in the Assisted Area were elementary school teachers who were members of the MGMP Elementary School Teachers in Garut Regency. The implementation period for this community service program is from February to August 2025. The teachers invited was 15, and the training would be conducted in two formats: face-to-face and online. Two face-to-face sessions were planned, while the online sessions were conducted via WhatsApp. The method used to introduce the working principles and key components of SIDILANwas a combination of informative and Interactive Lecture Demonstrations (ILD). The informative method was used to provide a brief explanation of the working principles of the SIDILAN simulation and its main components. The demonstration method was used to demonstrate, through modeling, how SIDILAN could be applied to training (Cresswell, John & Cresswell, 2018). To solve the problem and achieve the goals, the methods used are described in Table 3.

Table 3. Problem Solving, Process and Method and Results

Problem	Process and Method	Results
1. Low ability and skills in using virtual media for learning. 2. Knowledge and skills in using SIDILAN media to develop learning media. 3. Low SIL skills in the era of the industrial revolution 4.0.	1. Training using the Interactive Lecture Demonstration method 2. Practical use of computers or mobile phones using SIDILAN to produce appropriate inquiry-based learning 3. Training and mentoring in teaching conceptual skills using ILD	1. Elementary school teachers who are members of the Garut Regency MGMP received training in the use of SIDILAN. 2. Teachers are able to use SIDILAN in their lessons. 3. Teachers are able to link SIDILAN results to science lesson plans. 4. Elementary school teachers have the ability to develop SIL skills in science concepts. 5. Elementary school teachers have digital skills.

Work procedures that can be carried out to overcome partner problems in SIDILAN training, as well as improve the skills they already have through training in using SIDILAN for independent learning.

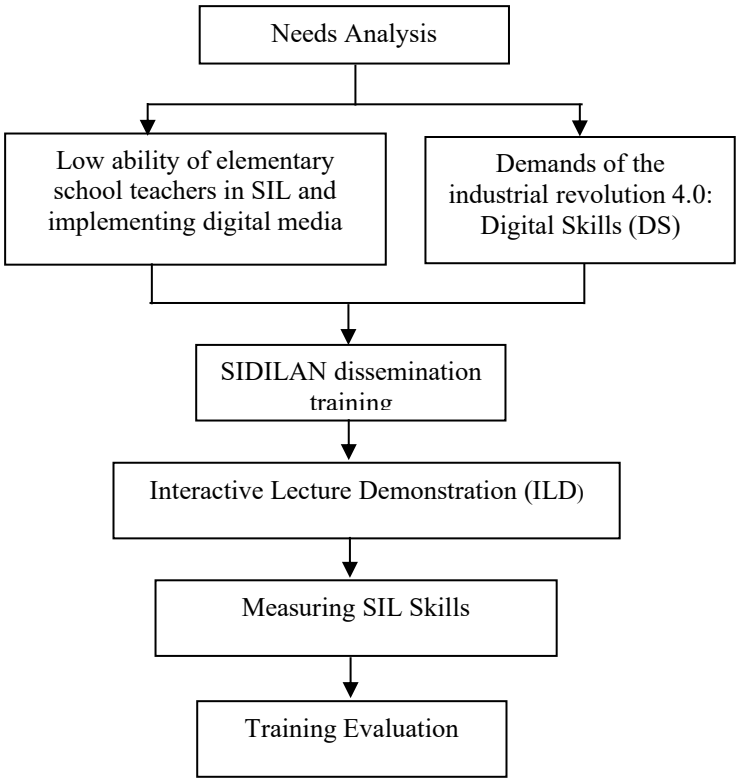

Figure 1. Implementation Flow of Faculty-Managed PKM Program

Based on the figure 1. the Work Procedure Plan for Faculty-Managed PKM activities, which supports the steps in implementing the proposed solutions, can be explained in detail as follows:

1. Training on the Use of SIDILAN for Elementary School Teachers for Science Learning

The training provided to partners aims to provide additional knowledge and skills to improve teacher productivity in developing science learning. The training aligns with the partners' needs, namely the use of SIDILAN and Science Inquiry-based classroom management. The steps in implementing this training are a) Formulating relevant training materials; b) Creating a training schedule; c) Preparing training tools and materials; d) Assigning Instructor Duties; e) Implementing the training; f) Conducting an evaluation

SIDILAN training is conducted over two sessions, each lasting 5 hours. Additional time will be provided if necessary. This training aims to provide skills in designing inquiry methods, media, and products. Therefore, it is hoped that teachers can design science lessons that accommodate various learning styles.

2. Dissemination of SIDILAN to Support Teachers' SIL

This activity aims to disseminate SIDILAN and implement it in elementary school science learning. The main objective of this dissemination is to provide the ability to use applications and the internet to support science learning. This internet media can be used as an effective means to expand virtual learning media that can be accessed from anywhere and at any time. The unity of all these elements not only creates a pleasing aesthetic but also fosters interactive communication and facilitates easy access to the media content. The stages of activities carried out in the PKM program consist of the implementation stage.

The implementation stage of the program begins with the preparation stage and concrete socialization to members, namely science teachers in Indonesia. The complete stages are explained as follows:

a. Preparation Stage

The preparation stage includes: a)Establishing a community service consisting of lecturers and students with relevant expertise; b) Needs Analysis by conducting surveys or interviews to identify teacher needs related to SIL and SIDILAN; c) Material Preparation: Preparing materials for socialization, training, and guidance relevant to teacher needs and program objectives; d) Developing SIDILAN by selecting SIDILAN programs appropriate to the science material taught and teacher characteristics; e) Preparing logistics, such as location, equipment, materials, and supplies.

b. Socialization Stage

The socialization stage involves: a) Program Introduction: Conducting socialization sessions with science teachers about the objectives, benefits, and stages of the community service program; b) Motivating teachers to improve their SIL, understand, and utilize SIDILAN in their learning; c) Discussion: Opening discussions about teachers' challenges and expectations regarding science learning.

c. Training Stage

The training stage involves: a) SIDILAN Training: Training teachers in selecting, using, and developing SIDILAN that is effective and engaging for teachers; b) Integration Training: Training teachers in integrating SIDILAN into science learning to improve teachers' SIL.

d. Technology Implementation Stage.

The technology implementation stage involves: a) Classroom implementation, which involves applying the knowledge and skills acquired in training to each class; b) Use of SIDILAN in science teaching to facilitate teacher understanding; c) Adaptation, which involves teachers adjusting the use of SIDILAN to suit their needs and characteristics.

e. Mentoring Stage

The mentoring stage involves: a) Observations by the community service team of teachers implementing SIDILAN in the classroom; b) Discussions between the service team and teachers regarding challenges and difficulties encountered in implementation; c) The service team provides solutions and suggestions to overcome these challenges; d) The community service team provides moral and material support to teachers in implementing SIDILAN.

f. Evaluation Stage

The evaluation stage involves collecting, analyzing, and reporting data in the following ways: a) Collecting data from teachers on the effectiveness of SIDILAN implementation in improving SIL; b) Analyzing data to determine the impact of the community service program on improving SIL for teachers; c) Preparing an evaluation report containing findings, conclusions, and recommendations for program improvement.

Evaluation of the Community Service Program Implementation will be conducted comprehensively and involve various relevant parties, including the community service team, participating teachers, and teachers. The evaluation aims to measure the program's effectiveness in achieving its stated objectives, namely improving teacher competency in implementing and utilizing SIDILAN and developing SIL-oriented learning. The evaluation method used quantitative data collection: pre-tests and post-tests to measure improvements in teachers' understanding and skills related to SIDILAN and SIL Scores were converted into normalized gain values (NGV) using the following equation.

$$< g >= \frac{\text{posttest} - \text{pretest}}{\text{maximum score} - \text{pretest}} x\ 100\%$$

NGV interpretation is calculated as follows: >70%: High, 30-70%: Medium, <30%: Low (Hake, 1999)

A questionnaire was used to collect data on teacher perceptions of the program, perceived benefits, and challenges faced in implementing SIDILAN. The SIDILAN questionnaire used in this community service used an instrument that had been validated and proven reliable in SIDILAN product development research (Darman et al, 2024b). The collected data were analyzed to determine the program's impact on improving teacher competency and learning outcomes. The Evaluation results will be used as a basis for future program improvements and to compile a final report on community service activities.The collected data were analyzed by examining the percentage of teacher responses for each indicator. The evaluation results will be used as a basis for future program improvements and to compile a final report on the community service activities.

g. Program Sustainability

The Program Sustainability phase includes dissemination, community development, and ongoing support, including: a) Disseminating evaluation results and information about SIDILAN to other teachers through seminars, workshops, or publications; b) EstabSILhing a community of science teachers committed to improving SIL through SIDILAN; c) Providing ongoing support and guidance to teachers to continue developing and implementing SIDILAN. These stages can be tailored to the needs and characteristics of the partners, as well as resource availability. The most important aspect is the commitment and cooperation of all relevant parties to achieve the program's goals, namely improving the quality of science learning and scientific inquiry literacy.

The sustainability of the Community Service Program is a primary concern. Following the completion of the program, several strategies will be implemented to ensure the program continues to provide benefits to teachers and students, including the estabSILhment of a Community of Practitioners as a forum for the science teacher community committed to improving SIL through SIDILAN. This community will serve as a platform for teachers to share experiences, knowledge, and resources, and support each other in implementing innovative learning approaches. The community service team will continue to provide regular mentoring to teachers, both online and offline. This mentoring aims to help teachers overcome challenges they may face in implementing SIDILAN, as well as provide moral and material support.

3. Results and Discussion

3.1. Implementation of the Community Service Program

The implementation of the community service program starts from preparation, socialization, training, implementation of SIDILAN technology, mentoring, evaluation, and sustainability. The SIDILAN product that has been developed can be accessed online at the page: https://phylament.serral.org/ , then select What is Your Learning Style? Click start. If you want to be faster, you can access it directly at the page: https://s.id/SIDILAN research results: https://learning-gate.com/index.php/2576-8484/article/view/2352 shown in Figure 2.

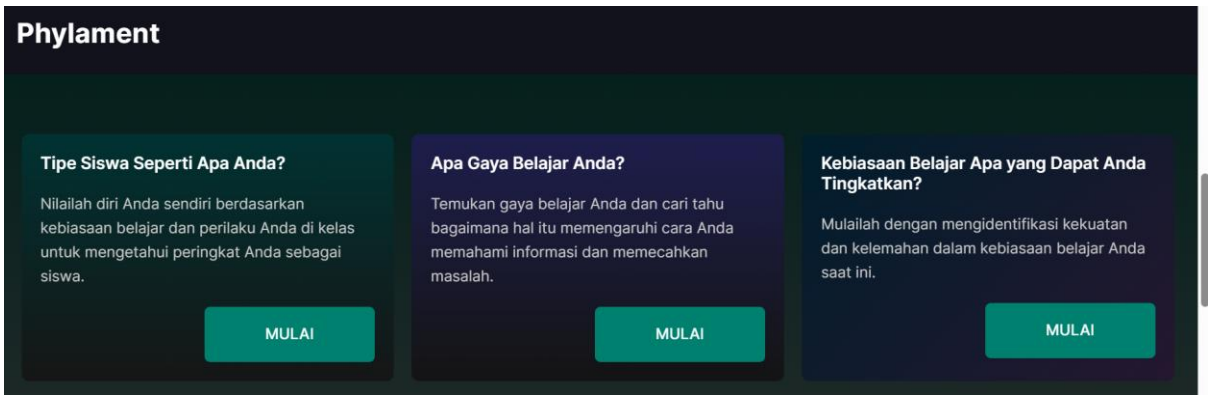

Figure 2. SIDILAN Online for detecting learning styles.

SIDILAN Online, to detect learning styles, begins by opening the page and then the "What is your learning style?" dialog box. Then, you complete 20 questions that will identify your learning style. SIDILAN will then inform you how your learning style affects how you understand information and solve problems, as shown in Figure 3.

The score indicates a person's learning style; the results above show one example of a student's learning style. The following is an explanation of the scores. Students tend to be predominantly auditory and visual, with the same score of 35%, and tactile or kinesthetic, with 30%. Furthermore, SIDILAN will provide recommendations to teachers and students on appropriate learning recommendations to achieve optimal learning outcomes. Training on the use of SIDILAN using ILD began with a pre-test. Teachers were then trained to use SIDILAN and apply it in elementary school science lessons. The stages of the SIDILAN training are shown in Figure 4.

Figure 4. Training on the Use of SIDILAN

Figure 4 shows elementary school teachers practicing using the SIDILAN application using mobile phones and laptops. After completing the training, a post-test was conducted to assess improvements in LIS knowledge.

3.2. Teacher Pretest and Posttest Results

Based on the results of the teachers' SIL pretest and posttest, the N-Gain scores for each teacher and the average N-Gain for the teachers overall were obtained. The pretest, posttest, and SIL improvement results for teachers trained by SIDILAN are presented in Table 2.

Table 2. Pretest, Posttest, and SIL Improvement Results for Teachers

No.	Teacher Code	Pretest	Posttest 1	%Pretest	%Posttest 1	< g >	N-Gain
1	G1	50	95	0.50	0.95	0.90	High
2	G2	30	80	0.30	0.80	0.71	High
3	G3	20	80	0.20	0.80	0.75	High
4	G4	20	80	0.20	0.80	0.75	High
5	G5	25	80	0.25	0.80	0.73	High
6	G6	45	85	0.45	0.85	0.73	High
7	G7	30	70	0.30	0.70	0.57	Currently
8	G8	30	80	0.30	0.80	0.71	High
9	G9	20	85	0.20	0.85	0.81	High
10	G10	20	80	0.20	0.80	0.75	High
11	G11	20	80	0.20	0.80	0.75	High
12	G12	20	90	0.20	0.90	0.88	High
13	G13	35	80	0.35	0.80	0.69	Currently
14	G14	20	80	0.20	0.80	0.75	High
15	G15	45	100	0.45	1.00	1.00	High
Maximum Value		45	70	0.20	0.70	< g >	High
Minimum Value		20	31	0.49	1.00		
Rata-Rata		28.67	83.00	0.29	0.83	0.76	

Based on Table 2, information was obtained that there was an increase in SIL knowledge for 13 teachers trained using the SIDILAN application in their learning, categorized as High. Furthermore, SIL knowledge for 2 teachers was categorized as

Medium. Overall, there was an increase in teacher abilities with an N-Gain value of 0.76, categorized as High. Based on the above data, it was found that elementary school teachers' SIL improved significantly after participating in SIDILAN training. Overall, teachers experienced improvements in knowledge of SIL, knowledge of student learning styles, knowledge of the relationship between SIL and learning styles, and scientific inquiry learning design that facilitates various student learning styles.

Scientific inquiry literacy is crucial for elementary school teachers because it enhances the ability to foster critical thinking and problem-solving skills in students (li *et al,* 2023). This literacy equips teachers to create engaging learning environments that promote active student participation, ultimately preparing students for the complexities of modern society (Wibowo *et al.,* 2021; Fontoura *et al.,* 2020). This aligns with their increased ability to integrate real-life processes and practices into their teaching (Wibowo *et al.,* 2023). Furthermore, SIL can foster teacher motivation in preparing lessons (Akerson *et al.,* 2023). This, in turn, positively impacts students' communication skills and enhances scientific literacy competencies in science subjects (Darman, 2024a).

Further research illustrates the importance of scientific inquiry literacy for elementary school teachers, as it enables them to create engaging learning environments and encourage student activity (Schwartz, 2023; Wibowo *et al* 2022). This literacy develops students' critical thinking, responsible behavior, and character, ultimately preparing them to effectively address the challenges of modern society. Furthermore, SIL is crucial for elementary school teachers to effectively develop students' inquiry skills and foster positive scientific attitudes, ensuring a strong foundation in science education from elementary to university levels (Darman *et al.,* 2024c; Anam *et al.,* 2023). Scientific inquiry literacy is crucial for elementary school teachers because it enhances their ability to engage students in critical thinking, fosters a deeper understanding of science, and promotes interdisciplinary connections, ultimately contributing to the development of informed and engaged citizens.

Integrating teachers' scientific inquiry literacy knowledge with an understanding of students' learning styles is crucial for improving student learning outcomes in science education. This synergy fosters an environment where inquiry-based learning can thrive, ultimately leading to increased scientific literacy among students. Teachers with strong inquiry literacy can effectively implement inquiry-based research lessons, which have been shown to significantly improve students' scientific literacy (Duncan *et al,* 2021). Knowledge of inquiry practices enables teachers to engage students in scientific argumentation and communication, essential for developing literacy skills in science (Pringle, 2020). Recognizing diverse learning styles allows teachers to tailor their inquiry-based approaches, ensuring that all students can meaningfully engage with scientific concepts (Nayak, 2025). Students are more likely to develop sustained interest in science when lessons are tailored to their learning preferences (Toli & Kallery, 2021), leading to better academic performance. Teachers' knowledge of science inquiry literacy is crucial for effectively integrating literacy into science instruction, accommodating diverse student learning styles, and enhancing conceptual understanding during the inquiry phase, ultimately fostering deeper student engagement and understanding.

The ability to design scientific inquiry learning that accommodates students' diverse learning styles is crucial for fostering effective engagement and understanding in science education. Adapting inquiry-based approaches to diverse learning preferences enhances students' critical thinking (Wibowo *et al.,* 2020), motivation, and overall learning outcomes. This adaptability enables educators to create more inclusive and effective learning environments (Lynn, 2021). Furthermore, inquiry learning models that incorporate student choice have been shown to increase motivation and engagement, leading to better learning outcomes. This aligns with research findings that different learning styles, such as kinesthetic or audio-visual, can significantly influence the effectiveness of inquiry-based learning. For example, kinesthetic learners often excel in hands-on inquiry activities (Oktaviani *et al.,* 2023). Effective inquiry design provides scaffolding that helps students navigate complex scientific concepts, promoting deeper understanding and self-directed learning (Duncan et al., 2021).

The integration of technology into scientific inquiry learning is crucial for accommodating diverse learning styles among students. By leveraging a variety of technological tools, educators can create dynamic and interactive learning environments that encourage engagement and facilitate a deeper understanding of scientific concepts. The use of SIDILAN technology in learning supports a variety of inquiry tasks and helps students engage with scientific phenomena in meaningful ways. This aligns with the use of animation and simulation in science learning (Yılmaz, 2023; Darman *et al.,* 2019). Technology can also be tailored to meet a variety of learning preferences, from collaborative websites for social learners to modeling software for analytical thinkers (Darman *et al.,* 2024a; *Lynn*, 2021). Technology can bridge gaps in required resources in learning (Darman, 2023), ensuring all students have equal opportunities to engage in inquiry-based learning, thus promoting inclusivity (Lu *et al.,* 2025).

Improve teachers' Scientific Inquiry Literacy (SIL), which is closely related to several Higher Education Performance Indicators. This activity contributes to the Higher Education Performance Indicator, namely "students who have off-campus learning experiences." Through this community service, lecturers and students can interact directly with the community, particularly science teachers in schools. Furthermore, this community service also supports lecturers in conducting research and community service that benefits society and industry. The dissemination of SIDILAN is a concrete manifestation of lecturers' dedication to the community, particularly in improving the quality of science education. The results of this community service are expected to provide significant benefits for science teachers in improving their competencies, which will ultimately impact the quality of learning and teachers' scientific inquiry literacy.

3.3. Teacher Perceptions of SIDILAN

Based on a questionnaire administered to elementary school teachers who participated in the training, the information presented in Table 3 was obtained.

Table 3. Recapitulation Of Teacher Response Questionnaire

No.	Indicator	% Teacher Agreement
1	Ease of use of SIDILAN	100
2	Speed of Sidilan in detecting student learning styles	100
3	Validity of the proposed learning recommendations based on student learning styles in SIDILAN	100
4	regarding the likelihood of teachers using SIDILAN to assist the teaching and learning process,	100
5	SIDILAN assists teachers in improving inquiry skills	100

Based on Table 3, information obtained for indicator 1, namely ease of use of SIDILAN, 100% of teachers agreed that SIDILAN was easy to operate. Furthermore, for indicator 2, information was obtained that all teachers agreed that SIDILAN could detect student learning styles more quickly than manual processing. Indicator 3, information was SIDILAN provided teachers with valid information about recommended learning for each student's learning style. Indicator 4, information was obtained that 100% of teachers would use SIDILAN to detect student learning styles before deciding on methods, models, and media to be used. Indicator 5, Information was teacher can teach science through effective inquiry.

Teachers involved in the SIDILAN training expressed many hopes, such as the following from a female teacher busy with children and other family responsibilities:

"I hope programs like SIDILAN can continue to be developed and expanded to more schools. Furthermore, ongoing support in the form of advanced training and adequate resources is needed to ensure optimal implementation of scientific inquiry methods."

Based on data analysis of the community service program, it was found that the Differential Learning System Dissemination Program (SIDILAN) has demonstrated promising results in improving Scientific Inquiry Literacy (SIL). This training's focus on professional development, a culture of literacy, and quality science learning has become crucial in addressing today's educational needs. Furthermore, a questionnaire administered to teachers revealed several benefits of using SIDILAN, including:

1. Improved Professional Competence

   Based on teacher responses in the questionnaire, SIDILAN training has significantly improved teachers' understanding of scientific inquiry methods. This aligns with findings that professional development enhances teachers' ability to manage learning based on classroom needs, thereby encouraging a more inquiry-based teaching approach (Wibowo *et al.,* 2024).

2. Developing a Culture of Literacy

   Elementary school science teachers reported that SIDILAN promotes a culture of literacy in schools and motivates teachers to improve their reading culture. This aligns with Pringle's (2020) findings that integrating literacy skills into science education can impact the overall quality of learning.

3. Improving the Quality of Science Learning

   Teachers who use SIDILAN in their lessons reported that its implementation engages students and makesthem more enthusiastic about science. This aligns with findings by Basam *et al.* (2017) that practical activities help students connect theoretical knowledge with practical applications, thereby improving their scientific literacy. Furthermore, other findings show that the implementation of SIDILAN can provide effectiveness and learning improvements in the range of 84-96% (Wibowo *et al.,* 2024c).

4. Conclusions

There was an increase in SIL knowledge for 13 teachers trained in using the SIDILAN application in their lessons, categorized as High. Furthermore, an increase in SIL knowledge for 2 teachers was categorized as Medium. Overall, there was an increase in teacher skills, with an N-Gain value of 0.76, categorized as High. Then based on the Teacher's response questionnaire, 100% of teachers agree that SIDILAN is easy to use, 100% of teachers agree that SIDILAN is easy to operate, Sidilan detects students' learning styles quickly compared to manual processing, SIDILAN can provide learning recommendations based on students' learning styles, SIDILAN provides valid information to teachers about recommended learning for each student's learning style, the use of SIDILAN to help the teaching and learning process, SIDILAN helps teachers decide on the methods, models, media to be used and helps teachers in improving inquiry skills so that they can teach science with good inquiry. So it can be said that SIDILAN shows promising results in improving Scientific Inquiry Literacy (SIL) through an innovative educational approach based on tests and Teacher response questionnaires.

The limitations of this community service include the small sample size and the short-term assessment of scientific inquiry literacy competencies. Further research on a larger sample and wider implementation of SIDILAN are needed to provide more diverse insights. Furthermore, the effectiveness of using SIDILAN in learning, using various media and science learning models, requires further investigation.

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6. Authors Note

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

7. References

Abell, S. K., & McDonald, J. T. (2006). Envisioning a curriculum of inquiry in the elementary school. In L. B. Flick & N. G. Lederman (Eds.), *Scientific inquiry and nature of science: Implications for teaching, learning, and teacher education* (pp. 249–261). Springer. https://doi.org/10.1007/978-1-4020-5814-1_12

Adrian, J. (2022). *Mitigating burnout in primary school teachers since the COVID-19 pandemic* (Doctoral dissertation, Walden University). ProQuest Dissertations Publishing.

Aisah, S. N., Sunarti, T., Prahani, B. K., Habibbulloh, M., Deta, U. A., Wibowo, F. C., & Sanjaya, L. A. (2024). Bibliometric analysis related to culture-based physics learning to improve critical thinking ability. In *AIP Conference Proceedings* (Vol. 3116, No. 1, 030008). AIP Publishing. https://doi.org/10.1063/5.0201234

Akerson, V. L., & Bartels, S. L. (2023). Elementary science teaching: Toward the goal of scientific literacy. In N. G. Lederman & J. S. Lederman (Eds.), *Handbook of research on science education* (pp. 528–558). Routledge.

Ali, N., Ullah, S., & Khan, D. (2022). Interactive laboratories for science education: A subjective study and systematic literature review. *Multimodal Technologies and Interaction, 6*(10), 85. https://doi.org/10.3390/mti6100085

Anam, R., Rahayu, U., Sekarwinahyu, M., & Sapriati, A. (2023). Elementary school teachers' understanding of inquiry skills and scientific attitude. *Al Ibtida: Jurnal Pendidikan Guru MI, 10*(2), 233–248. https://doi.org/10.24235/al.ibtida.snj.v10i2.12844

Antonio, R. P., & Prudente, M. S. (2024). Effects of inquiry-based approaches on students' higher-order thinking skills in science: A meta-analysis. *International Journal of Education in Mathematics, Science and Technology, 12*(1), 251–281. https://doi.org/10.46328/ijemst.3821

Astutik, S., Nuriman, N., Supeno, S., Wardayati, S. M., Arif, A., Dienda, S. W., & Wahyuni, N. I. (2025). Scaffolding based on scientific creativity learning (SSCL): An innovative learning model to improve students' skill in scientific creativity. *IJORER: International Journal of Recent Educational Research, 6*(1), 170–182. https://doi.org/10.46245/ijorer.v6i1.721

Atmojo, I. R. W., Ardiansyah, R., Setyaningrum, H. R., & Saputri, D. Y. (2024). Examining the relationship between science literacy, science process skills, and higher-order thinking skills in elementary teacher education students. *Al-Ishlah: Jurnal Pendidikan, 16*(4), 4517–4530. https://doi.org/10.35445/al-ishlah.v16i4.5807

Baroudi, S., & Rodjan Helder, M. (2021). Behind the scenes: Teachers' perspectives on factors affecting the implementation of inquiry-based science instruction. *Research in Science & Technological Education*, *39*(1), 68-89. https://doi.org/10.1080/02635143.2019.1651259

Bokayev, B., Torebekova, Z., Davletbayeva, Z., & Zhakypova, F. (2021). Distance learning in Kazakhstan: Estimating parents' satisfaction of educational quality during the coronavirus. *Technology, Pedagogy and Education, 30*(1), 27–39. https://doi.org/10.1080/1475939X.2020.1865192

Cho, H., Han, I., Kim, H. N., & Yoo, I. (2008). Analysis of elementary teachers' views on barriers in implementing inquiry-based instructions. *Journal of the Korean Association for Research in Science Education, 28*(8), 901–921. http://www.koreascience.or.kr/article/ArticleFullRecord.jsp?cn=GHGOBX_2008_v28n8_901

Creswell, John W & J. David Creswell. 2018. Research Design Qualitative, Quantitative, and Mixed Methods Approaches Fifth Edition. SAGE Publications, Inc

Darman, D. R. (2021). Online problem-based learning (OPBL) assisted by simulation media in basic physics learning to improve creative thinking skills. *Gravity: Jurnal Ilmiah Penelitian dan Pembelajaran Fisika, 7*(1), 11–20. https://doi.org/10.30870/gravity.v7i1.9000

Darman, D. R., Ahmad, N. J., Coştu, B., & Prahani, B. K. (2023). Effectiveness of interactive digital module physics (IDMP) based on interactive lecture demonstration of vector concepts. *Journal of Physics Education Research, 12*(2), 101–115.

Darman, D. R., Anriani, N., Wibowo, F. C., Faizin, M. N., Samsudin, A., Suhandi, A., & Nulhakim, L. (2019). Effectiveness of learning support of asset (assessment simulation test) for reconstruction physics conception. In *Journal of Physics: Conference Series* (Vol. 1280, No. 5, 052063). IOP Publishing. https://doi.org/10.1088/1742-6596/1280/5/052063

Darman, D. R., Suhandi, A., Kaniawati, I., & Samsudin, A. (2024c). Profile of science inquiry literacy (SIL) achievements of pre-service physics teachers using Rasch model measurements. *Gravity: Jurnal Ilmiah Penelitian dan Pembelajaran IPA, 10*(1), 35–46. https://doi.org/10.30870/gravity.v10i1.22222

Darman, D. R., Suhandi, A., Kaniawati, I., Samsudin, A., & Wibowo, F. C. (2024a). Virtual laboratory in physics education: A systematic review. In *AIP Conference Proceedings* (Vol. 3116, No. 1, 040008). AIP Publishing. https://doi.org/10.1063/5.0216789

Darman, D. R., Suhandi, A., Kaniawati, I., Samsudin, A., & Wibowo, F. C. (2024b). Development and validation of scientific inquiry literacy instrument (SILI) using Rasch measurement model. *Education Sciences, 14*(3), 322. https://doi.org/10.3390/educsci14030322

Duncan, R., Av-Shalom, N. Y., & Chinn, C. A. (2021). Inquiry and learning in science. In E. K. Fischer (Ed.), *The Routledge handbook of science education* (pp. 325–344). Routledge. https://doi.org/10.4324/9781315685779-22

Fontoura, H., Corrêa Pereira, E. G., & Figueira, S. (2020). Formação de professores de ciências no Brasil e alfabetização científica: Desafios e perspectivas. *Revista Unipluriversidad, 20*(1), 103–126. https://doi.org/10.17533/udea.unipluri.20.1.07

Gultom, L. N., & Alwi, N. A. (2024). Implementasi literasi sains dalam pembelajaran IPA di sekolah dasar. *Jurnal Sadewa, 2*(3), 170–179. https://doi.org/10.61132/sadewa.v2i3.952

Hake, R. R. (1999). Analyzing Change/Gain Score. Dept. of Physics, Indiana University.

Harefa, E. (2023). Implementation of scientific inquiry approach for enhancing scientific literacy among elementary students. *International Research and Academic Online Journal, 1*(1), 32–38. https://doi.org/10.56207/iraono.v1i1.131

Kumar, V., Choudhary, S. K., & Singh, R. (2024). Environmental socio-scientific issues as contexts in developing scientific literacy in science education: A systematic literature review. *Social Sciences & Humanities Open, 9,* 100765. https://doi.org/10.1016/j.ssaho.2023.100765

Kwak, Y. (2011). A study on actual conditions and ways to improve primary school science teaching. *Journal of the Korean Earth Science Society, 32*(4), 422–434. https://doi.org/10.5467/JKESS.2011.32.4.422

Li, T., Miller, E., Chen, I. C., Bartz, K., Codere, S., & Krajcik, J. (2023). The relationship between teacher's support of literacy development and elementary students' modelling proficiency in project-based learning science classrooms. In V. R. Dawson (Ed.), *Inquiry-based science in the primary classroom* (pp. 44–58). Routledge.

Lu, K., Ji, T., Lu, F., & Shadiev, R. (2025). Bridging the digital divide: The mediating role of learning engagement between technology usage approaches and higher order thinking skills in a technology-enhanced inquiry-based learning environment. *Educational Technology Research and Development, 73*(2), 1–21. https://doi.org/10.1007/s11423-024-10456-7

Lynn, L. (2021). Effective integration of technology in inquiry learning: Themes and examples. In D. Ifenthaler & S. Yau (Eds.), *Handbook of research on integrating technology into contemporary classrooms* (pp. 664–676). IGI Global. https://doi.org/10.4018/978-1-7998-3476-2.ch041

Mina, K. M., & Oraiz, C. (2024). Unveiling the reasons behind teachers' embrace of traditional teaching methods. *Psychology and Education: A Multidisciplinary Journal, 20*(8), 1004–1023.

Nayak, S. (2025). Innovative methods for addressing diverse learning styles. In *Power of differentiation* (pp. 159–176). Springer. https://doi.org/10.1007/978-3-031-55555-0_10

Oktaviani, A. M., Misyanto, M., Maulana, G., Jayadi, J., Utomo, E., & Gumelar, G. (2023). The influence of inquiry learning model in improving students' critical thinking skills in view of learning styles in science learning in elementary schools. *Edubasic Journal, 5*(1), 25–35. https://doi.org/10.17509/ebj.v5i1.55961

Pan, X. (2022). Exploring the multidimensional relationships between educational situation perception, teacher support, online learning engagement, and academic self-efficacy in technology-based language learning. *Frontiers in psychology*, *13*, 1000069. https://doi.org/10.3389/fpsyg.2022.1000069

Pringle, R. M. (2020). Literacy skills and science learning. In K. A. Renninger & S. E. Hidi (Eds.), *Motivation, learning, and science education* (pp. 59–86). Springer. https://doi.org/10.1007/978-3-030-59550-0_5

Rahayu, U., Anam, R. S., Sekarwinahyu, M., & Sapriati, A. (2022). The inquiry skills of teachers in elementary school. *Jurnal Ilmiah Sekolah Dasar, 6*(2), 228–235. https://doi.org/10.23887/jisd.v6i2.46909

Rosyida, K. M., & Prahani, B. K. (2025). Enhancing students' critical thinking skills in physics: Exploring problem-based learning and mobile technology integration in rotational dynamics education. *Advances in Mobile Learning Educational Research, 5*(1), 1301–1313. https://doi.org/10.25082/AMLER.2025.01.013

Rudolph, J. L. (2024). Scientific literacy: Its real origin story and functional role in American education. *Journal of Research in Science Teaching, 61*(3), 519–532. https://doi.org/10.1002/tea.21988

Schwartz, R. S., Lederman, J. S., & Enderle, P. J. (2023). Scientific inquiry literacy: The missing link on the continuum from science literacy to scientific literacy. In N. G. Lederman & J. S. Lederman (Eds.), *Handbook of research on science education* (pp. 749–782). Routledge.

Setyabudi, R., Wibowo, F. C., & Susanti, D. (2024). Interactive digital module physics (SIDILAN) based on problem-based learning (PBL) on the concept of work and energy. In *Prosiding Seminar Nasional IPA (E-Journal)* (Vol. 12). Universitas Negeri Malang.

Supriyatman, S., Kade, A., Darmadi, I. W., Miftah, M., Supriyadi, S., & Ismail, I. (2024). Competence of junior high schools' science teachers in implementing laboratory teaching: A case study in Palu, Central Sulawesi. *Jurnal Penelitian Pendidikan IPA, 10*(6), 3114–3122. **DOI:** 10.29303/jppipa.v10i6.7510

Toli, G., & Kallery, M. (2021). Enhancing student interest to promote learning in science: The case of the concept of energy. *Education Sciences, 11*(5), 220. https://doi.org/10.3390/educsci11050220

Wibowo, F. C. (2021). Unveil problem-based learning on physics learning: A literature review. In *Journal of Physics: Conference Series* (Vol. 2019, No. 1, 012045). IOP Publishing. https://doi.org/10.1088/1742-6596/2019/1/012045

Wibowo, F. C., & Nasbey, H. (2024c). Interactive digital module physics (SIDILAN) berbasis inquiry pada konsep energi alternatif. In *Prosiding Seminar Nasional IPA (E-Journal)* (Vol. 12). Universitas Negeri Malang.

Wibowo, F. C., Nasbey, H., Alizkan, U., Darman, D. R., Coştu, B., & Ahmad, N. J. (2024a). Design and effectiveness of augmented reality of greenhouse effect integration model physics independent learning. *Pegem Journal of Education and Instruction, 14*(3), 134–145. **DOI:** https://doi.org/10.47750/pegegog.14.03.13%20

Wibowo, F. C., Nasbey, H., Sanjaya, L. A., & Darman, D. R. (2020). Development of game open online physics instructional (GOOPI) for improving 21st-century careers: Creativity skill (21-CC: CS). *International Journal of Instructional Technology, 9*(3), 55–64. https://doi.org/10.30534/ijatcse/2020/20932020

Wibowo, F. C., Nasbey, H., Suprihatin, S., Kusuma, A. A. K., Darman, D. R., & Coştu, B. (2024d). System differential learning for detecting learning styles in science education for students with learning disabilities. *Edelweiss Applied Science and Technology, 8*(6), 1849–1869. https://doi.org/10.55214/25768484.v8i6.2352

Wibowo, F. C., Nasbey, H., Suprihatin, S., Kusuma, A. A., Darman, D. R., & Coştu, B. (2024b). System differential learning for detecting learning styles in science education for students with learning disabilities. *Edelweiss Applied Science and Technology, 8*(6), 1849–1869. https://doi.org/10.55214/25768484.v8i6.2352

Wibowo, F. C., Sanjaya, L. A., Darman, D. R., Basyir, S. N., & Gregersen, A. F. (2022). Technology augmented reality integration hydrometeorology (TARIH) as media solution in disaster management for physics teacher candidates. *Journal of Natural Science and Integration, 5*(1), 1–10. https://doi.org/10.24014/jnsi.v5i1.20001

Wibowo, F. C., Setiawan, A., Darman, D. R., Suhandi, A., Samsudin, A., Faizin, M. N., & Permana, P. N. D. (2021). Effectiveness of virtual physics laboratory (VPL) with dry cell microscopic simulation (DCMS) to promote inquiry activity about the battery. In *Journal of Physics: Conference Series* (Vol. 1772, No. 1, 012006). IOP Publishing. https://doi.org/10.1088/1742-6596/1772/1/012006

Yanti, F., Lufri, L., & Ahda, Y. (2025). Current trends in augmented reality to improve senior high school students' skills in Education 4.0: A systematic literature review. *Open Education Studies, 7*(1), 20240053. https://doi.org/10.1515/edu-2025-0053

Yılmaz, Ö. (2023). The role of technology in modern science education. In Ö. Baltacı (Ed.), *Current research in education* (Vol. 6, pp. 35–60). Özgür Publications.

Yuberti, Y., Komikesari, H., Yusandika, A. D., Wibowo, F. C., & Diansah, I. (2024). Guide e-book on developing Android-based smart key: A learning media for the application of electronic circuits in higher education. *Indonesian Journal of Science and Mathematics Education, 7*(2), 145–158. DOI: 10.24042/ijsme.v5i1.23862