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Scientific Literacy Outcomes Following Discovery Learning with Simple Experiments

A Quasi-Experimental Study in Fourth-Grade Science

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ABSTRACT

Scientific literacy remains a major challenge in elementary science education because many students struggle to explain scientific phenomena, evaluate investigations, and interpret evidence. Although Discovery Learning and experimental activities have demonstrated positive outcomes, evidence regarding their integrated use in elementary schools, with scientific literacy as the primary outcome, remains limited. This study investigated the effect of Discovery Learning supported by simple experiments on fourth-grade students' scientific literacy. A quantitative quasi-experimental pretest-posttest control-group design was employed. Participants were 68 fourth-grade students from SDN SPG Latihan Ambon, selected through simple random sampling and assigned to an experimental group (n = 35) and a control group (n = 33). Data were collected using a scientific literacy test developed from the PISA 2018 framework and analyzed using descriptive statistics and analysis of covariance (ANCOVA). The experimental group achieved a higher post-test mean score (82.80) than the control group (61.94). ANCOVA demonstrated a significant effect of the instructional model on scientific literacy ($F = 237.390$, $p < 0.001$), with a large effect size (partial eta squared = 0.785). These findings indicate that integrating Discovery Learning with simple experiments can strengthen scientific literacy by engaging students in active inquiry, evidence-based reasoning, and meaningful knowledge construction. The study provides empirical support for combining discovery-oriented instruction with experimentation in elementary science. Future studies should include larger and more diverse samples, investigate the durability of learning gains,

and assess implementation across different science topics, grade levels, and educational settings.

Keywords
Discovery Learning
Elementary Science Education
Inquiry-Based Learning
Scientific Literacy
Simple Experiments

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Introduction

Scientific literacy (SL) refers to an individual's capacity to engage with science-related issues and ideas as a critical and reflective citizen. Operationally, scientific literacy is defined as the ability to use scientific knowledge and processes to identify problems and draw conclusions based on empirical evidence [1], [2]. The development of scientific literacy, on the one hand, helps children develop their scientific concepts as well as connect and apply this knowledge; on the other hand, it enhances higher-order learning skills such as problem-solving, analytical competence, and informed decision-making [3], [4]. The development of children's scientific literacy during the early years supports the acquisition of scientific conceptual knowledge by enabling them to connect and apply it through play-based activities. Such activities integrate scientific concepts and knowledge into children's play experiences, allowing them to connect, apply, and reinforce their understanding, thereby promoting scientific literacy [5]. Scientific literacy is an essential competency that enables individuals to play a significant role in the advancement of science, technology, and society [6].

Scientific literacy is also recognized as an important component of Global Citizenship Education (GCE), playing a crucial role in equipping learners with the knowledge and skills needed to understand various issues and develop into scientifically literate citizens [7]. With this foundation, students are expected to contribute actively to the advancement of science, technology, and society. Therefore, science curricula should provide learning experiences that are relevant to future challenges. Learning materials should also be aligned with both local and global developments so that learners can practice making informed decisions regarding science-related social issues [8]. To date, scientific literacy remains one of the primary goals of science education. However, the concept of scientific literacy has been interpreted in various ways, and its definition continues to evolve in response to the social, cultural, and political contexts in which it is situated [9]. Scientific literacy can be understood from multiple perspectives, ranging from an individual's ability to process scientific facts and concepts and interpret scientific data, to the ways in which society collectively engages with scientific knowledge and processes. The mastery of scientific literacy skills is essential for everyone,

regardless of whether they pursue careers as scientists, because science-related issues are frequently encountered in everyday life. Regardless of whether students choose science-related fields of study, the development of scientific literacy skills remains a fundamental necessity. In addition to cultivating these competencies within themselves, students are also expected to promote the growth of a culture of scientific literacy within their communities [10].

The level of scientific literacy among students in countries participating in the Programme for International Student Assessment (PISA) remains a significant concern. The PISA 2018 results showed that a substantial proportion of students across participating countries performed at the lower levels of the scientific literacy proficiency scale, indicating difficulties in applying scientific knowledge and reasoning to unfamiliar situations [11]. In Indonesia, this issue remains particularly concerning, with approximately 60% of students performing below Level 2 on the six-level PISA science proficiency scale [11]. Students performing at these lower proficiency levels are generally able to apply basic scientific knowledge and inquiry methods to familiar situations but have limited ability to use scientific reasoning to explain phenomena, evaluate investigations, or interpret evidence in more complex contexts. These findings indicate that many Indonesian students are still at the early stages of developing the ability to engage in scientific reasoning related to science, technology, and associated issues. Previous studies have also shown that most secondary school science students demonstrate scientific literacy at Levels 1 and 2, corresponding to the Nominal and Functional levels of scientific literacy, respectively [12]. onsistent with these findings, another study reported that 48% of junior high school students demonstrated scientific literacy skills at low to very low levels [13].

Scientific literacy refers to an individual's ability to understand complex scientific discussions, master sophisticated scientific concepts, and critically evaluate information based on available evidence. At the elementary school level, scientific literacy plays an important role in developing knowledge while fostering environmental awareness. Children possess continuously developing learning capacities, and their natural curiosity can be utilized as a means of learning science. Such experiences can cultivate a lasting appreciation of science and its applications in everyday life [14]. Although the development of scientific literacy in elementary schools faces various challenges, these efforts offer substantial benefits. Many students learn science only at a basic level of understanding because instructional practices tend to emphasize memorization rather than analytical and critical-thinking skills. In addition, limited funding, the use of curricula that are not aligned with contemporary developments, and insufficient teacher preparedness for science instruction are factors that may hinder the effective implementation of science education in elementary schools [15]. Social and cultural factors also influence the successful development of students' scientific literacy. Differences in

social and cultural backgrounds may reduce students' engagement in the learning process and hinder their acceptance of scientific concepts. To address these challenges, various measures are required, including enhancing public understanding of scientific concepts, creating more inclusive learning environments, and expanding access to equitable and high-quality science education for all learners [16].

Over the past few decades, educational paradigms have undergone significant changes, shifting from teacher-centered approaches focused on information delivery to student-centered learning that encourages learners to construct knowledge independently [17]. This shift highlights the importance of understanding how students effectively construct their own knowledge. In this context, the Discovery Learning model has emerged as a relevant instructional approach because it emphasizes students' active involvement in understanding scientific concepts through exploration, experimentation, and problem-solving activities [18]. Several studies have reported the successful implementation of the Discovery Learning (DL) model in science education. The application of Discovery Learning has been shown to significantly improve students' scientific literacy [19], [20]. Discovery Learning is an inquiry-based instructional approach that encourages students to investigate independently, build upon prior knowledge and experiences, and utilize intuition, imagination, and creativity to seek new information and discover facts, relationships, and new understandings [21]. Discovery Learning is a student-centered instructional method that focuses on learners' active participation in the learning process. In this approach, teachers serve not only as classroom managers but also as mentors and facilitators who guide students in constructing their own knowledge by presenting problems to be solved through scientific procedures. The benefits of Discovery Learning include fostering dynamic collaboration among students, increasing learning interest and engagement, enhancing long-term knowledge retention, and creating opportunities for more personalized learning experiences [22]. Discovery Learning operationalizes these principles by encouraging learners to construct knowledge through guided inquiry and exploration within meaningful contexts [23]. This approach was developed to help students acquire a range of essential skills required in the twenty-first century and therefore has the potential to serve as a foundation for the development of more innovative instructional models capable of addressing existing educational limitations. However, despite its numerous advantages in supporting the learning process, Discovery Learning also faces several challenges that must be carefully considered and addressed to ensure its effective implementation and maximize learning outcomes [24].

Experimentation is a teaching method that involves conducting experiments by observing both the processes and outcomes of the activities and is considered one of the learning approaches aimed at enhancing students' cognitive abilities [25]. The use of simple

science experiments is exploratory and participatory in nature. In the context of elementary education, science is not merely a collection of facts but rather a process of learning through direct experience. Introducing science in an engaging and enjoyable manner helps cultivate scientific thinking skills, such as observing, drawing conclusions, and communicating findings [26]. The implementation of experimental methods has been shown to increase students' active participation and learning motivation [27]. Experimental learning provides substantial benefits for students because it enables them to conduct hands-on investigations and gain direct experience. Furthermore, it promotes critical thinking in problem-solving and helps learners understand cause-and-effect relationships through the experiments they perform. Although this method has certain limitations, these challenges can still be addressed by utilizing available natural resources and learning materials within the surrounding environment [28]. Based on the discussion above, there is a need for an instructional model capable of bridging the gap between the demands of twenty-first-century scientific literacy and the conventional teaching practices that continue to dominate classroom instruction. Discovery Learning based on simple experiments offers an active learning approach that enables students to discover scientific concepts through independent inquiry and investigation.

A growing body of research has demonstrated the positive effects of Discovery Learning and experimental activities on science learning outcomes. Previous studies have reported improvements in academic achievement, conceptual understanding, critical thinking skills, and scientific reasoning following the implementation of discovery-based learning approaches. Similarly, experimental learning has been associated with increased student engagement and a deeper understanding of scientific concepts. Despite these promising findings, several limitations remain within the existing literature. First, many studies have primarily focused on secondary and higher education contexts, leaving elementary school settings relatively underexplored. Second, previous research has often examined Discovery Learning and experimental activities separately rather than investigating their combined effects. Third, although numerous studies have assessed academic achievement, fewer have specifically examined scientific literacy using internationally recognized literacy frameworks. These limitations highlight the need for further investigation into instructional approaches that integrate Discovery Learning with simple experimental activities, particularly in elementary science education. Combining these approaches may provide a more comprehensive learning experience by simultaneously supporting inquiry, conceptual understanding, scientific reasoning, and evidence-based thinking. Therefore, this study seeks to address the existing research gap by examining the effect of Discovery Learning based on simple experiments on elementary school students' scientific literacy. Given the absence of studies specifically investigating the effectiveness of this instructional model in the study area,

this research aims to determine the influence of a simple experiment-based Discovery Learning model on students' scientific literacy.

Literature Review

A. Constructivist Learning Theory in Science Education

The evolution of educational paradigms over the past several decades has shifted the focus of instruction from teacher-centered knowledge transmission toward student-centered knowledge construction. This transformation is largely influenced by constructivist learning theory, which posits that learners actively build their understanding through interactions with their environment and prior experiences. Meaningful learning occurs when students are actively engaged in the process of discovering concepts and constructing their own understanding, rather than merely receiving information from teachers. Such learning experiences promote deeper conceptual understanding and facilitate the long-term retention of knowledge [29]. Knowledge acquired through personal discovery tends to be retained longer and applied more effectively in different contexts. Within science education, constructivism provides a theoretical foundation for learning environments that emphasize inquiry, exploration, and problem-solving. Students are encouraged to formulate questions, investigate phenomena, test hypotheses, and construct explanations based on evidence. Such experiences help learners develop conceptual understanding while simultaneously strengthening higher-order thinking skills. Inquiry-based learning environments play an important role in promoting students' conceptual understanding by encouraging active engagement in the learning process. When supported by appropriate instructional guidance, such environments can facilitate meaningful knowledge construction and improve learning outcomes. Moreover, inquiry-based science instruction has been found to positively influence both students' academic achievement in science and their scientific reasoning abilities, making it an effective approach for science education [30], [31]. Constructivist classrooms differ substantially from traditional classrooms because students are viewed as active participants in the learning process. Teachers serve as facilitators who guide students through meaningful learning experiences rather than acting solely as sources of information. This perspective is particularly important in elementary science education because children learn more effectively when they are directly involved in observing, manipulating, and investigating scientific phenomena. Therefore, instructional approaches derived from constructivist principles are considered highly relevant for improving science learning outcomes and scientific literacy.

B. Discovery Learning as an Inquiry-Oriented Instructional Model

Discovery Learning represents one of the most widely recognized instructional models grounded in constructivist principles. The model emphasizes active student engagement in exploring concepts, identifying relationships, and generating conclusions through systematic

investigation. Rather than providing direct explanations at the beginning of instruction, teachers create learning situations that encourage students to discover scientific principles through guided exploration. The effectiveness of Discovery Learning stems from its ability to promote active cognitive engagement. During discovery activities, students analyze information, compare observations, identify patterns, and formulate explanations. These processes require learners to engage in higher-order thinking rather than memorizing information. Discovery-oriented instruction is particularly effective when supported by appropriate guidance because students can focus their attention on meaningful aspects of the learning task without becoming overwhelmed [32]. Recent studies continue to support the benefits of Discovery Learning in science education. Learning environments designed around discovery principles promote deeper conceptual understanding and stronger student engagement [33]. Similarly, discovery-based learning contributes significantly to the development of twenty-first-century competencies, including critical thinking, creativity, communication, and problem-solving [34]. In addition to cognitive benefits, Discovery Learning has motivational advantages. Students often experience greater curiosity and ownership of learning when they actively participate in constructing knowledge. This increased engagement can foster positive attitudes toward science and encourage lifelong learning habits. Consequently, Discovery Learning is increasingly viewed as a promising approach for addressing contemporary educational demands.

C. Scientific Literacy and Inquiry Competencies

Current perspectives on scientific literacy emphasize the integration of knowledge, skills, and attitudes necessary for understanding and engaging with scientific issues. Scientific literacy extends beyond knowing scientific facts; it involves the ability to apply scientific knowledge, evaluate evidence, interpret data, and make informed decisions regarding personal and societal issues. Modern science education frameworks highlight inquiry competencies as fundamental components of scientific literacy. Students who are scientifically literate should be able to identify scientific questions, analyze evidence, construct explanations, and communicate conclusions effectively. These competencies closely resemble the practices used by scientists in generating and validating knowledge. Scientific literacy requires students to understand not only scientific concepts but also the nature of scientific inquiry itself. Learners must recognize how evidence is collected, evaluated, and used to support scientific claims [35]. Inquiry-based learning experiences are positively associated with higher levels of scientific literacy because students become actively involved in reasoning, investigation, and evidence-based decision-making [36]. The relationship between inquiry competencies and scientific literacy suggests that instructional models emphasizing active investigation may be particularly effective for developing literacy outcomes. By engaging students in authentic

scientific practices, educators can help learners develop the knowledge and reasoning skills required to navigate increasingly complex scientific and technological issues.

D. Experiential Learning Through Simple Experiments

Experiential Learning Theory provides another important perspective for understanding how students develop scientific understanding. According to Kolb, learning occurs through a cycle involving concrete experience, reflective observation, abstract conceptualization, and active experimentation. This framework highlights the importance of direct experiences in facilitating meaningful learning. Science education naturally aligns with experiential learning because scientific concepts are often best understood through observation and experimentation. Practical activities allow students to interact directly with scientific phenomena, transforming abstract ideas into tangible experiences. For elementary school students, whose cognitive development is still strongly tied to concrete experiences, experimentation becomes particularly valuable. Simple experiments offer numerous educational advantages. They encourage students to observe carefully, ask questions, formulate predictions, collect evidence, and evaluate outcomes. Through these activities, learners develop essential scientific process skills while simultaneously strengthening conceptual understanding. Hands-on science activities positively influence student motivation, conceptual learning, and engagement in science [37]. Moreover, experimental activities promote active participation and collaborative learning. Students often work together to conduct investigations, discuss findings, and interpret results. Such interactions contribute to the development of communication and argumentation skills that are essential components of scientific literacy. Experimental science instruction enhances students' investigative abilities and scientific reasoning by providing opportunities to engage directly with evidence-based inquiry [38].

Material and Methods

A. Research Design

The research method employed in this study was a quantitative approach using a quasi-experimental research design. The quantitative approach was chosen because the study aimed to objectively measure and analyze the effect of implementing a learning model on students' scientific literacy through numerical data. The research design used was the pretest–posttest control group design, which involved two groups: an experimental group and a control group [39]. The experimental group received treatment in the form of a simple experiment–based Discovery Learning model, while the control group participated in conventional instruction. This design was selected because it enables researchers to compare changes in students' scientific literacy before and after the treatment in both groups. Prior to the implementation of the learning activities, both groups were administered a pretest to determine students'

initial abilities and to ensure that the baseline conditions of the two groups were relatively equivalent. Following the treatment during the instructional process, both groups were given a posttest to measure the improvement in scientific literacy skills. Therefore, the effect of implementing the simple experiment–based Discovery Learning model on students' scientific literacy could be analyzed more accurately, as differences in initial abilities were controlled through the administration of the pretest.

B. Population and Sample

The population of this study consisted of all fourth-grade students at the SDN Latihan SPG Ambon Elementary School Complex, comprising 131 students distributed across four classes: Class IV-A (35 students), Class IV-B (33 students), Class IV-C (38 students), and Class IV-D (25 students). The sampling technique employed was simple random sampling, in which each unit within the sampling frame has an equal opportunity of being selected [40]. In this study, random sampling was conducted at the class level because the intervention was implemented using intact classes. All four fourth-grade classes were included in the sampling frame, and a lottery procedure was used to randomly select and assign the classes to the experimental and control groups. The lottery resulted in Class IV-A, consisting of 35 students, being selected as the experimental group, while Class IV-B, consisting of 33 students, was selected as the control group. The experimental group received the Discovery Learning model integrated with simple experiments, whereas the control group received conventional instruction. Thus, the final sample comprised 68 students from two intact classes. Although the classes were selected and assigned through a random lottery, individual students were not randomly assigned to the treatment conditions. Therefore, the study was appropriately characterized as a quasi-experimental pretest–posttest control-group design using intact classes.

C. Research Instrument

The data collection instrument used in this study was a scientific literacy test consisting of multiple-choice and essay questions that were developed based on the scientific literacy indicators outlined in the PISA 2018 framework. These indicators included: (1) Explaining phenomena scientifically, in which students were required to identify and evaluate explanations for natural phenomena, such as the effect of force on the motion of objects; (2) Evaluating and designing scientific investigations, which assessed students' ability to determine appropriate procedures or equipment for an experiment on frictional force; and (3) Interpreting data and evidence scientifically, where students were expected to draw valid conclusions from experimental data presented in tables or graphs. Prior to its implementation, the instrument underwent validity and reliability testing involving 30 students outside the research sample. Validity was assessed both logically through expert judgment and statistically using the Pearson Product–Moment correlation formula. The overall validity coefficient was

0.825, indicating that the instrument demonstrated a high level of validity. Based on the SPSS analysis, of the 20 test items examined with a critical r-value of 0.361, most items were found to be valid (e.g., Item 1 obtained an r-value of 0.678), while items that did not meet the criterion of *r*calculated > *r*table were excluded from the instrument. Reliability testing was subsequently conducted using Cronbach's Alpha to ensure the consistency of the instrument. The results indicated a reliability coefficient of 0.795, demonstrating a high level of reliability (above 0.60). Therefore, the instrument was considered highly suitable for measuring students' scientific literacy.

D. Intervention Procedure

The intervention was conducted over four instructional sessions, with each session lasting 70 minutes, for a total instructional time of 280 minutes. The intervention focused on the science topic of force and motion and was implemented in the experimental group using a Discovery Learning model integrated with simple experiments. The learning activities followed the six stages of Discovery Learning: stimulation, problem identification, data collection, data processing, verification, and generalization. Students were actively engaged in observing scientific phenomena and conducting simple experiments related to force and motion. Student Worksheets (LKPD) were used to guide students through the observation of phenomena, implementation of experiments, recording and analysis of observations, discussion of findings, and formulation of conclusions. The integration of simple experiments was intended to provide students with direct experiences of scientific phenomena and facilitate connections between abstract scientific concepts and observable events. Students worked collaboratively throughout the learning activities, while the teacher facilitated the discovery process by providing guiding questions, monitoring students' investigations, and assisting them in interpreting and verifying their findings.

The experimental group received instruction according to the prepared instructional module, with the teacher and researcher coordinating the implementation of the learning activities. In the first session, students were introduced to force and its effects on objects through stimulation and simple experimental activities. The second session focused on friction and the factors affecting friction, which students investigated through guided experiments and observations. The third session addressed the benefits and disadvantages of friction in everyday life through experimentation, discussion, data interpretation, and verification. The fourth session focused on generalization and the application of the concepts learned, followed by the scientific literacy assessment. Throughout the intervention, students were encouraged to identify problems, collect and process data, discuss their findings, verify their explanations, and formulate conclusions based on evidence.

The control group (Class IV-B) received conventional instruction on the same topic of force and motion and for the same total instructional duration as the experimental group. The instruction was conducted by the classroom teacher and researcher based on the same general instructional objectives and prepared instructional materials. The conventional instructional approach included teacher explanations, question-and-answer activities, guided discussions, demonstrations, independent reading, and individual assignments. Each session consisted of 10 minutes for the opening activity, 50 minutes for the core learning activities, and 10 minutes for the closing activity. The first session focused on the concept of force as a push or pull and its effects on the movement of objects, supported by teacher explanations, demonstrations, questioning, and individual exercises. The second session addressed friction and the factors affecting friction. Students read the relevant material independently, while the teacher explained the concept and provided examples involving rough and smooth surfaces. The third session focused on the benefits and disadvantages of friction in everyday life through teacher explanations and classroom discussions. The fourth session was devoted to the scientific literacy assessment, during which students independently completed multiple-choice and essay questions under supervision.

The control group did not receive the Discovery Learning-based activities or the simple experimental activities implemented in the experimental group. Instead, instruction relied on conventional classroom activities, including explanations, demonstrations, questioning, guided discussion, reading, and individual assignments. Thus, both groups received instruction on the same science topic for the same total instructional duration, while the instructional approaches and learning activities differed according to the assigned condition. To assess the fidelity of the intervention, a structured observation sheet was administered throughout all four instructional sessions. The observation instrument included indicators of teacher and student activities corresponding to the planned Discovery Learning stages and experimental activities. Teacher-activity indicators covered stimulation, problem identification, group formation, experimentation, data collection, data processing, verification, feedback, and conclusion drawing. Student-activity indicators included participation in identifying problems, conducting experiments using the Student Worksheets (LKPD), recording and analyzing experimental data, presenting findings, and drawing conclusions. Observations were conducted during each of the four instructional sessions, and ratings were recorded for each indicator at every session. The teacher-activity observation sheet consisted of 12 indicators, whereas the student-activity observation sheet consisted of 11 indicators. The observation results were used to document the extent to which the planned instructional procedures were implemented consistently throughout the intervention.

E. Data Analysis Techniques

The data analysis procedures included both descriptive and inferential statistical analyses. Preliminary assumption testing was conducted through normality and homogeneity tests. Subsequently, hypothesis testing was performed using Analysis of Covariance (ANCOVA) with the assistance of SPSS software to examine the effect of the learning model on students' scientific literacy while controlling for students' initial abilities (pretest scores) as a covariate variable. All statistical analyses were conducted at a significance level of 5% ($\alpha = 0.05$).

Results and Discussions

A. Descriptive Analysis

The presentation of the research findings begins with a description of the data to provide an overview of students' scientific literacy achievement in both research groups. Descriptive statistics were used to analyze the pretest and posttest scores in order to examine the distribution of scores, means, and standard deviations before and after the treatment was administered. A summary of the descriptive statistical data for the experimental and control groups is presented in Table 1.

Table 1. Descriptive Statistics of Students' Scientific Literacy Scores

Group	Test	N	Minimum	Maximum	Mean	SD
Discovery Learning with Simple Experiments (Experimental Group)	Pre-test	35	32	64	48.80	7.91
	Post-test	35	72	96	82.80	6.53
Conventional Instruction (Control Group)	Pre-test	33	32	60	45.58	7.42
	Post-test	33	48	80	61.94	7.31

Based on Table 1, both groups demonstrated relatively similar initial abilities, as reflected in their pretest mean scores of 48.80 for the experimental group and 45.58 for the control group. However, after the treatment was administered, the experimental group, which was taught using the simple experiment–based Discovery Learning model, showed a substantial improvement, achieving a posttest mean score of 82.80. In contrast, the control group, which received conventional instruction, attained a posttest mean score of only 61.94.

To further examine the extent of improvement in students' scientific literacy following the learning intervention, a normalized gain (N-Gain) analysis was conducted. N-Gain provides an estimate of the relative improvement in students' achievement by taking into account both the pretest and posttest scores. The analysis was performed for both the experimental and control groups to determine whether the improvement in scientific literacy differed between the two instructional approaches. The results are presented in Table 2.

Table 2. N-Gain Analysis of Students' Scientific Literacy

Group	Pretest Mean	Posttest Mean	Mean N-Gain	Interpretation
Experimental	48.80	82.80	0.6640	Moderate
Control	45.58	61.94	0.3006	Moderate

B. Assumption Testing

Before conducting hypothesis testing to address the research questions, the scientific literacy data were subjected to a series of prerequisite tests to ensure that they met the assumptions required for parametric statistical analysis.

1. Normality Test

   The normality test was conducted to determine whether the scientific literacy data from both groups were normally distributed. The test was performed using the kolmogorov–smirnov test at a significance level of 5%. The results revealed a significance value (*Asymp. Sig.*) of 0.064. Since the p-value was greater than 0.05 ($p > 0.05$), it was concluded that the scientific literacy data were normally distributed.

2. Homogeneity Test

   The homogeneity test was conducted using levene's test to verify whether the variances of the experimental and control groups were homogeneous. The results showed a significance value based on the mean of 0.698. Because this value exceeded 0.05 ($p > 0.05$), the data were considered to have homogeneous variances. Since both assumptions of normality and homogeneity were satisfied, the data were deemed appropriate for further analysis using ANCOVA.

3. Hypothesis Testing (ANCOVA)

   Hypothesis testing in this study was conducted using Analysis of Covariance (ANCOVA) with the assistance of SPSS software. This analysis was selected to examine the effect of the simple experiment–based Discovery Learning model on students' scientific literacy while controlling for students' initial ability (pretest scores) as a covariate. The results of the Tests of Between-Subjects Effects are presented in Table 3.

Table 3. ANCOVA Results for Students' Scientific Literacy

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	18512.143	2	9256.072	119.773	0.000	0.787
Pre-test (Covariate)	2116.368	1	2116.368	27.386	0.000	0.296
Group (Instructional Model)	18345.142	1	18345.142	237.390	0.000	0.785
Error	5023.107	65	77.279			

Based on the data presented in Table 3, the primary focus of the analysis is the "Class" row, which represents the effect of the instructional model implemented. The results revealed an F-value of 237.390 with a significance level of 0.000. Since this significance value is far below the established threshold (0.000 < 0.05), the statistical decision was to reject the null hypothesis (H_0) and accept the alternative hypothesis (H_a). These findings provide empirical evidence that the implementation of a simple experiment–based Discovery Learning model has a highly

significant effect on enhancing the scientific literacy of fourth-grade students at the SD Latihan SPG Ambon Complex. By controlling for the covariate variable (pretest scores), it was confirmed that the observed improvement in students' abilities resulted from the instructional intervention implemented in the experimental class.

Furthermore, the effectiveness of the model is supported by a partial eta squared value of 0.785. This value indicates that the simple experiment–based Discovery Learning model accounted for approximately 78.5% of the variance in students' scientific literacy achievement. The remaining 21.5% was attributable to other factors beyond the treatment examined in this study. These results suggest that the model constitutes a dominant factor in promoting scientific literacy development at the elementary school level. One of the key factors contributing to the success of this study was the use of innovative simple experimental tools constructed from everyday materials, such as toy cars, friction-based surfaces, and different types of shoe soles. From a psychological perspective, the students were at the concrete operational stage of cognitive development. At this stage, students' logical reasoning abilities depend heavily on the availability of tangible objects that can be directly manipulated. The use of concrete learning media served as a cognitive bridge, making the previously abstract concepts of force and motion more accessible and meaningful. By physically touching, moving, and observing objects firsthand, students experienced a substantial reduction in cognitive load when internalizing scientific principles. These hands-on activities not only enhanced conceptual understanding through direct observation but also fostered important scientific attitudes, including careful observation, curiosity, and effective teamwork in solving problems.

The findings of this study reveal that discovery learning based on simple experiments significantly enhances students' scientific literacy. The substantial improvement in posttest scores and the large effect size indicate that the instructional intervention was effective in facilitating students' ability to explain scientific phenomena, evaluate investigations, and interpret scientific evidence. These results suggest that integrating discovery-oriented learning with hands-on experimentation creates a learning environment that actively engages students in constructing scientific knowledge rather than merely receiving information from the teacher. One possible explanation for this improvement is that discovery learning encourages students to participate in authentic learning experiences in which they are required to observe, investigate, analyze, and draw conclusions independently. Such a student-centered learning environment promotes deeper conceptual understanding because learners are directly involved in generating and validating knowledge. Students who actively engage in exploration and inquiry are more likely to develop stronger scientific reasoning and problem-solving skills than those exposed to traditional instructional approaches [41], [42].

Through the process of discovery, students become more aware of the relationship

between scientific concepts and real-life situations, which is a key characteristic of scientific literacy. The effectiveness of the intervention can also be explained by the role of simple experiments in supporting experiential learning. In this study, students learned abstract concepts related to force and motion through the direct manipulation of concrete materials. These findings are consistent with recent studies indicating that hands-on, experiment-based learning activities facilitate deeper understanding because students can directly observe cause-and-effect relationships and verify scientific explanations through evidence. Experimental activities provide learners with opportunities to engage in scientific practices, including observation, measurement, interpretation, and evidence-based argumentation, all of which are central components of scientific literacy [43], [44]. Another important finding is that the integration of Discovery Learning and simple experiments appears to enhance student engagement during science instruction. Students in the experimental group were actively involved in investigating phenomena, discussing findings, and communicating conclusions. Such engagement is crucial because scientific literacy develops most effectively when learners participate in meaningful inquiry processes rather than passively receiving information. Recent evidence suggests that inquiry-rich learning environments significantly increase students' willingness to engage with scientific issues and strengthen their confidence in applying scientific knowledge to new situations [45], [46].

The present findings also support recent studies indicating that discovery-based learning contributes to the development of 21st-century competencies. Scientific literacy is increasingly viewed as a multidimensional competency that encompasses critical thinking, problem-solving, communication, and evidence-based decision-making. Through experimental discovery activities, students are required not only to understand scientific concepts but also to collaborate, analyze information, and justify their conclusions. Such learning experiences are consistent with contemporary educational demands that emphasize competency-based learning and higher-order thinking skills [47]. Furthermore, the large effect size observed in this study suggests that combining Discovery Learning with simple experiments may provide greater benefits than implementing either approach independently. Previous research has often examined inquiry-based learning and experimental activities as separate instructional approaches. However, the present findings indicate that integrating these two approaches creates a synergistic effect by simultaneously supporting conceptual understanding, scientific reasoning, and active engagement. These results are consistent with recent studies reporting that integrated inquiry and experimental models produce stronger improvements in scientific competencies because students experience the complete cycle of scientific inquiry—from formulating questions and conducting experiments to interpreting evidence and drawing conclusions [48], [49].

From a practical perspective, these findings suggest that sophisticated laboratory facilities are not always necessary to enhance scientific literacy. The use of simple and readily available materials is sufficient to create meaningful science learning experiences. This has important implications for elementary schools with limited resources, particularly in developing regions. By utilizing low-cost materials and adopting a student-centered instructional approach, teachers can provide students with opportunities to engage in authentic scientific inquiry without requiring advanced equipment. Overall, the findings provide strong evidence that simple experiment–based Discovery Learning is an effective pedagogical strategy for improving the scientific literacy of elementary school students. This model promotes active knowledge construction, strengthens scientific reasoning, and encourages evidence-based thinking. These outcomes are particularly important for preparing students to face the increasingly complex scientific and technological challenges of the 21st century.

Conclusion

The expected findings of this study are that students exposed to Discovery Learning integrated with simple experimental activities demonstrate higher scientific literacy than those taught through conventional methods. The findings indicate that students who participated in the intervention achieved substantially greater improvements in scientific literacy. The ANCOVA results confirmed a statistically significant effect of the instructional model on students' scientific literacy, while the large effect size indicated that the intervention made a substantial contribution to improving students' abilities to explain scientific phenomena, evaluate scientific investigations, and interpret scientific evidence. This study addresses an important gap in the existing literature. Previous research has generally examined Discovery Learning and experimental activities as separate instructional approaches, with relatively limited attention to their integrated implementation in elementary science education. Moreover, empirical studies focusing specifically on scientific literacy as an outcome of Discovery Learning integrated with simple experiments at the elementary school level remain limited. The present findings provide empirical evidence that integrating Discovery Learning with simple experimental activities can enhance scientific literacy by promoting active inquiry, evidence-based reasoning, and meaningful construction of scientific knowledge. An important contribution of this study is the practical potential of using simple, readily accessible experimental materials.

The findings suggest that the development of scientific literacy does not necessarily require sophisticated laboratory facilities. Instead, carefully designed inquiry and experimental activities can provide meaningful learning experiences even in elementary schools with limited resources. This approach may therefore offer a feasible instructional strategy for teachers seeking to strengthen students' scientific literacy through active and

inquiry-oriented learning. Despite these contributions, several limitations should be acknowledged. First, the study was conducted in a single elementary school with a relatively small sample, which may limit the generalizability of the findings. Second, the intervention focused on a specific science topic, namely force and motion, and was implemented over a relatively short period. Therefore, the findings should be interpreted with caution when applied to other educational contexts, student populations, or science topics. Future research should involve larger and more diverse samples across different schools and educational settings and examine the long-term effects of simple experiment-based Discovery Learning on scientific literacy. Further studies could also investigate its application across different science topics and its potential effects on other 21st-century competencies, including critical thinking, problem-solving, creativity, and scientific attitudes. Such research would provide a more comprehensive understanding of the educational value and broader applicability of simple experiment-based Discovery Learning in elementary science education.

Conflict of Interest

The authors declare no conflict of interest.

References

[1] R. C. Laugksch, "Scientific literacy: a conceptual overview," *Sci. Educ.*, vol. 84, no. 1, pp. 71–94, 2000, doi: 10.1002/(SICI)1098-237X(200001)84:1<71::AID-SCE6>3.0.CO;2-C.
[2] D. Dani, "Scientific Literacy and Purposes for Teaching Science : A Case Study of Lebanese Private School Teachers," *Int. J. Environ. Sci. Educ.*, vol. 4, no. 3, pp. 289–299, 2009.
[3] J. Holbrook and M. Rannikmae, "The meaning of scientific literacy," *Int. J. Environ. Sci. Educ.*, vol. 4, no. 3, pp. 275–288, 2009.
[4] W. R. Johnson, "Why engaging in the practices of science is not enough to achieve scientific literacy," *Am. Biol. Teach.*, vol. 78, no. 5, pp. 370–375, 2016, doi: 10.1525/abt.2016.78.5.370.370.
[5] G. Roy, S. Sikder, and W. Letts, "Understanding the process of scientific literacy development among children in the early years through play and intentionality," *Res. Sci. Educ.*, vol. 56, pp. 673–694, 2026, doi: 10.1007/s11165-025-10291-9.
[6] A. Sholahuddin, N. Anjuni, Leny, and C. Faikhamta, "Project-based and flipped learning in the classroom: a strategy for enhancing students' scientific literacy," *Eur. J. Educ. Res.*, vol. 12, no. 1, pp. 239–251, 2020, doi: 10.12973/eu-jer.12.1.239.
[7] M. Pownall, P. Birtill, and R. Harris, "Student perceptions of global citizenship education in the university curriculum," *Perspect. Policy Pract. High. Educ.*, vol. 30, no. 2, pp. 112–121, 2026, doi: 10.1080/13603108.2024.2422501.
[8] H. A. Yacoubian, "Scientific literacy for democratic decision-making," *Int. J. Sci. Educ.*, vol. 40, no. 3, pp. 308–327, 2018, doi: 10.1080/09500693.2017.1420266.
[9] M. N. Meléndez, G. R. Guerrero, and C. González, "What is meant by scientific literacy in the curriculum ? A comparative analysis between Bolivia and Chile," *Cult. Stud. Sci. Educ.*, vol. 18, no. 3, pp. 937–958, 2023, doi: 10.1007/s11422-023-10190-3.
[10] N. C. Kelp, M. Mccartney, M. A. Sarvary, J. F. Shaffer, and M. J. Wolyniak, "Developing science literacy in students and society: Theory, Research, and Practice :," *J. Microbiol. Biol. Educ.*, vol. 24, no. 2, pp. 1–4, 2023, doi: 10.1128/jmbe.00058-23.
[11] OECD, *PISA 2018 Assessment and Analytical Framework*. 2019.
[12] I. Shahzadi and A. Nasreen, "Assessing scientific literacy levels among secondary school science students of district lahore," *Bull. Educ. Res.*, vol. 42, no. 3, pp. 1–21, 2020.
[13] I. W. Merta, I. P. Artayasa, Kusmiyati, N. Lestari, and D. Setiadi, "The profile of science literacy and instruction models can increase science literacy capability," *J. Pijar MIPA*, vol. 15, no. 3, pp. 223–228, 2020, doi: 10.29303/jpm.v15i3.1889.
[14] M. Baltikian, S. Kärkkäinen, and J. Kukkonen, "Assessment of scientific literacy levels among

secondary school students in Lebanon: Exploring gender-based differences," *Eurasia J. Math. Sci. Technol. Educ.*, vol. 20, no. 3, pp. 1–18, 2024, doi: 10.29333/ejmste/14279.

[15] A. B. Simamora, W. Widodo, and I. G. M. Sanjaya, "Innovative learning model : Improving the Students ' scientific literacy of junior high school," *IJORER Int. J. Recent Educ. Educ.*, vol. 1, no. 3, pp. 271–285, 2020, doi: 10.46245/ijorer.v1i3.55.

[16] W. Tan, C. Huang, and H. Xiang, "Improving the scientific literacy of primary school students from the perspective of double reduction: practical inspiration," in *Salud Ciencia y Tecnología - Serie de Conferencias*, 2024, pp. 1–13. doi: 10.56294/sctconf2024987.

[17] R. Weinhandl, S. Baldinger, and V. Riegler, "Design Characteristics for Discovery Learning within Digital Mathematics Learning Environments from Students' Perspectives," *Int. J. Sci. Math. Educ.*, vol. 23, pp. 1–29, 2025, doi: 10.1007/s10763-025-10619-x.

[18] R. D. Honomichl and Z. Chen, "The role of guidance in children's discovery learning," *Wiley Interdiscip. Rev. Cogn. Sci.*, vol. 3, no. 6, pp. 615–622, 2012, doi: 10.1002/wcs.1199.

[19] E. W. Winarni, "Analysis of Language and Scientific Literacy Skills for 4th Grade Elementary School Students through Discovery Learning and ICT Media," *Int. J. Instr.*, vol. 13, no. 2, pp. 213–222, 2020, doi: 10.29333/iji.2020.13215a.

[20] F. Hariyanti, I. K. Budayasa, and R. Setianingsih, "Design and Evaluation of a Guided Discovery Learning Model to Enhance Junior Secondary Students ' Statistical Literacy," *J. Educ. Cult. Soc.*, vol. 16, no. 2, pp. 685–708, 2025, doi: 10.15503/jecs2025.3.685.708.

[21] A. Mukherjee, "Effective Use of Discovery Learning to Improve Understanding of Factors That Affect Quality," *J. Educ. Bus.*, vol. 90, no. 8, pp. 413–419, 2015, doi: 10.1080/08832323.2015.1081866.

[22] A. Kistia, D. Armanto, and A. Sudrajat, " hcvn ,," *Br. J. Educ.*, vol. 5, no. 11, pp. 1–11, 2017.

[23] R. E. Slavin, "Cooperative learning in elementary schools," *Educ. 3-13*, vol. 43, no. 1, pp. 5–14, 2015, doi: 10.1080/03004279.2015.963370.

[24] T. Helda and E. Gani, "The validity and practicality of discovery-group learning models to improve 21st century skills of high school students," *rEFLections*, vol. 31, no. 3, pp. 1408–1433, 2024, doi: 10.61508/refl.v31i3.277735.

[25] T. De Jong *et al.*, "Let ' s talk evidence – The case for combining inquiry-based and direct instruction," *Educ. Res. Rev.*, vol. 39, pp. 1–14, 2023, doi: 10.1016/j.edurev.2023.100536.

[26] P. T. H. Tu *et al.*, "Experimental teaching by scientific methods for developing students ' natural finding capacity in teaching natural science in vietnamese high schools," *World J. Educ.*, vol. 12, no. 6, pp. 1–8, 2022, doi: 10.5430/wje.v12n6p1.

[27] Y.-T. Hsu and S. W.-Y. Lee, "Support for self-regulated learning in immersive virtual reality – An experimental design for science learning," *Educ. Inf. Technol.*, vol. 31, pp. 269–300, 2026, doi: 10.1007/s10639-025-13807-y.

[28] N. Q. Linh and N. T. Hang, "Enhancing 8th grade students ' environmental science competency through science , technology , society , and environment-oriented teaching : an experimental study," *Discov. Educ.*, vol. 5, pp. 1–20, 2026, doi: 10.1007/s44217-026-01279-2.

[29] J. S. Bruner, "The act of discovery," 1961. doi: 10.4324/9780203088609-13.

[30] E. M. Furtak, T. Seidel, H. Iverson, and D. C. Briggs, "Experimental and quasi-Experimental studies of inquiry-based science teaching: A meta-analysis," *Rev. Educ. Res.*, vol. 82, no. 3, pp. 300–329, 2012, doi: 10.3102/0034654312457206.

[31] A. W. Lazonder and R. Harmsen, "Meta-analysis of inquiry-based learning: Effects of guidance," *Rev. Educ. Res.*, vol. 86, no. 3, pp. 681–718, 2016, doi: 10.3102/0034654315627366.

[32] A. Ouzzine, E. Jadida, R. Erguig, E. Jadida, and A. Boudlal, "Discovery-based teaching methodology : A framework for quality teaching and learning," *J. Appl. Lang. Cult. Stud.*, vol. 5, no. 1, pp. 9–27, 2022.

[33] A. A. Gebremeskel, M. A. Ayele, and T. E. Wondimuneh, "Student engagement , conceptual-understanding , and problem-solving ability in learning plane geometry through an integrated instructional approach," *EURASIA J. Math. Sci. Technol. Educ.*, vol. 21, no. 5, pp. 1–22, 2025, doi: 10.29333/ejmste/16391.

[34] S. Miglani, V. Verma, M. Agrawal, J. Singh, and J. Patel, "Competency-based learning as a framework for holistic development of 21st century learners in school education," *Discov. Educ.*, vol. 5, pp. 1–27, 2026, doi: 10.1007/s44217-026-01268-5.

[35] Y. Mulyono, S. Sapuadi, Y. Yuliarti, and S. Sohnui, "International journal of advanced and applied sciences a framework for building scientific literacy through an inquiry learning model using an ethnoscience approach," *Int. J. Adv. Appl. Sci.*, vol. 11, no. 8, pp. 158–168, 2024.

[36] D. Cairns and S. Areepattamannil, "Exploring the relations of inquiry-based teaching to science

achievement and dispositions in 54 countries," *Res. Sci. Educ.*, vol. 49, no. 1, pp. 1–23, 2019, doi: 10.1007/s11165-017-9639-x.
[37] P. Potvin and A. Hasni, "Analysis of the decline in interest towards school science and technology from grades 5 through 11," *J. Sci. Educ. Technol.*, vol. 23, no. 6, pp. 784–802, 2014, doi: 10.1007/s10956-014-9512-x.
[38] M. Reith, A. Nehring, M. Reith, and A. Nehring, "fostering scientific reasoning competencies : investigating impacts of cross- and within-content area experimentation using the competency triad fostering scientific reasoning competencies : investigating using the competency triad," *Int. J. Sci. Educ.*, vol. 48, no. 1, pp. 73–97, 2026, doi: 10.1080/09500693.2024.2394708.
[39] A. D. Harris, "The use and interpretation of quasi-experimental studies in medical informatics," *J. Am. Med. Informatics Assoc.*, vol. 13, no. 1, pp. 16–23, 2006, doi: 10.1086/420936.
[40] S. Noor, O. Tajik, and J. Golzar, "Simple random sampling," *Int. J. Educ. Lang. Stud.*, vol. 1, no. 2, pp. 78–82, 2022, doi: 10.22034/ijels.2022.162982.
[41] T. T. S. Strat, E. K. Henriksen, and K. M. Jegstad, "Inquiry-based science education in science teacher education: A systematic review," *Stud. Sci. Educ.*, vol. 60, no. 2, pp. 191–250, 2024, doi: 10.1080/03057267.2023.2207148.
[42] T. Musengimana, L. L. Yadav, J. Uwamahoro, and G. Nizeyimana, "Instructional strategies for enhancing students ' problem-solving skills in physics : A systematic review," *Discov. Educ.*, vol. 4, pp. 1–24, 2025, doi: 10.1007/s44217-025-00733-x.
[43] S. Alvina, Mellyzar, S. R. Zahara, "Hands-on, minds-on: The impact of home-based experiments on scientific process skills of Indonesian middle school students," *Sci. Educ. Int.*, vol. 36, no. 3, pp. 341–348, 2023, doi: 10.33828/sei.v36.i3.9.
[44] G. Stylos, "Transforming understanding of scientific inquiry : The impact of a year - long explicit - reflective intervention on greek preservice primary teachers," *Sci. Educ.*, pp. 1–34, 2026, doi: 10.1007/s11191-026-00742-8.
[45] W. Wartono, J. Takaria, J. R. Batlolona, S. Grusche, M. N. Hudha, and Y. M. Jayanti, "Inquiry-discovery empowering high order thinking skills and scientific literacy on substance pressure topic," *J. Ilm. Pendidik. Fis. Al-Biruni*, vol. 7, no. 2, pp. 139–151, 2018, doi: 10.24042/jipfalbiruni.v7i2.2629.
[46] N. Madubun, M. Leasa, J. Pelamonia, and J. R. Batlolona, "Digital science learning with wordwall to enhance students ' cognitive learning outcomes on ecosystem concepts through discovery learning," *Form. J. Ilm. Pendidik. MIPA*, vol. 16, no. 1, pp. 29–40, 2026, doi: 10.30998/5gjvge98.
[47] F. Chen, Y. Zhang, and G. Chen, "Exploring the effects of technology-supported collaborative inquiry and students ' ICT competency on scientific literacy and subject knowledge in rural science classrooms," *Educ. Inf. Technol.*, vol. 30, pp. 18705–18732, 2025, doi: 10.1007/s10639-025-13512-w.
[48] M. Kersting, S. Karlsen, M. Ødegaard, and M. Olufsen, "Studying the quality of inquiry-based teaching in science classrooms . A systematic video study of inquiry-based science teaching in primary and lower-secondary schools," *Int. J. Sci. Educ.*, vol. 43, no. 17, pp. 1463–1484, 2023, doi: 10.1080/09500693.2023.2213386.
[49] S. Prayogi *et al.*, "Emphasizing reflective processes in scientific inquiry and its impact on preservice science teachers ' critical thinking skills," *Soc. Sci. Humanit. Open*, vol. 12, pp. 1–11, 2025, doi: 10.1016/j.ssaho.2025.101895.

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