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Development of an Outdoor Laboratory-Based Discovery Learning Model on the Characteristics of Living Things to Improve Students' Science Literacy and Science Process Skills at MTsN 3 Banda Aceh

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Abstract: This study aims to develop an outdoor laboratory-based Discovery Learning model on the characteristics of living things to improve scientific literacy and science process skills of students at MTsN 3 Banda Aceh. The method used is development research with the 4D model (Define, Design, Develop, Disseminate). Product validation was carried out by material experts and learning experts, while practicality was measured through teacher and student responses, and effectiveness was measured by N-gain and paired sample t-test. The validation results of material experts reached 85.27% and 85%, learning experts 84% and 86% (valid category). Teacher responses were 86.25% and student responses 86.62% (strong category). The N-gain value was 0.73 (high criteria) with a T-test significance value of 0.000 <0.05. It was concluded that the outdoor laboratory-based Discovery Learning model is valid, practical, and very effective in improving students' scientific literacy and science process skills.

Keywords: Discovery learning; Model development; Outdoor laboratory; Science literacy; Science process skills

Introduction

Education is the primary foundation for character building and the sustainable improvement of human resources. UNESCO (2015) emphasizes that education serves not only as a means of transferring knowledge but also as a tool for building moral and social values that can create a just and prosperous society. In line with the increasingly rapid dynamics of global development, reforming the education system is an unavoidable necessity. An adaptive and responsive curriculum to the needs of the times is considered key to the success of education in the modern era. As Nadim (2019) stated, developing a flexible and competency-based curriculum is a strategic step in preparing a generation capable of competing globally.

In the context of Natural Science (IPA) learning, the urgency of updating learning methods and models is increasingly pressing. As a branch of science that studies the universe and its phenomena, IPA demands a learning approach that is not merely theoretical but also empirical and based on direct experience. Suryabrata (2015) stated that effective science learning must be able to foster students' curiosity and analytical skills through a contextual and innovative approach. Furthermore, Wulandari et al. (2026) emphasized that integrating appropriate learning models is key to increasing the effectiveness of the science teaching and learning process, so that students not only memorize concepts but are able to apply them meaningfully in their daily lives.

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One of the topics that plays a crucial role in science learning is the characteristics of living things. This topic serves as the primary foundation that helps students understand the differences between living and non-living things, while also developing a deep understanding of the characteristics and life processes of living things (Purnama, 2021). A proper understanding of the characteristics of living things—such as breathing, moving, growing and developing, reproducing, being sensitive to stimuli, and requiring nutrition—is crucial in building the foundation of students' science knowledge (Sutrisno, 2018). Mastery of this topic is not sufficient through mere memorization of definitions; it must be internalized through direct experience, so that students are able to observe, classify, and conclude the characteristics of living things scientifically and systematically.

However, the reality on the ground, particularly at MTsN 3 Banda Aceh, shows conditions that are far from ideal. Initial observations revealed that the average student score on the characteristics of living things material was below the established Minimum Completion Criteria (KKM), which was 79. This problem does not stand alone, but rather reflects a more fundamental problem in the learning process. Students tend to be passive, less active in teaching and learning activities, and weak in the ability to identify and differentiate the characteristics of living things critically and analytically. This finding is in line with research by Sukarmin et al. (2018) which showed that the ongoing learning process still tends to be teacher-centered, so that students do not get adequate space to actively think, explore, and discover concepts independently.

This ineffective learning environment was also identified by Aprilinia et al. (2024), who concluded that the primary cause was the use of learning models that lacked variety and did not sufficiently challenge students to think critically and develop observation and analytical skills. On the other hand, scientific literacy and science process skills (SPS) are two fundamental competencies that students must master in the 21st century (A'yun & Subali, 2019; Kurnia et al., 2014). The OECD (2019) defines scientific literacy as an individual's ability to engage with scientific issues and scientific thinking as a reflective citizen, encompassing the ability to explain scientific phenomena, evaluate and design scientific questions, and interpret data scientifically. Meanwhile, science process skills encompass a range of scientific abilities such as observation, classification, prediction, communication, hypothesis formulation, and experimental planning (Liliasari, 2014; Afina et al., 2021; Fitriani et al., 2016).

The low scientific literacy of Indonesian students is also evident in the results of the Programme for International Student Assessment (PISA) survey, which consistently ranks Indonesia at the bottom compared to other countries. This situation indicates the need for a fundamental transformation in the science learning approach, from its original transmissive approach to a more constructive, exploratory, and authentic experience-based approach. In this context, the outdoor laboratory-based Discovery Learning model presents an innovative solution that is seen as capable of addressing this challenge (Chiappetta et al., 1991).

The Discovery Learning model positions students as active subjects who discover scientific concepts and principles for themselves through exploration and investigation. Bruner (1961), a pioneer of this model, stated that learning through discovery not only produces deeper understanding but also develops critical thinking and problem-solving skills. This model aligns with the constructivist theory developed by Piaget and reinforced by Novak (2017), which asserts that knowledge is actively constructed by individuals through meaningful interactions with their environment. In other words, students are not passive recipients of information, but rather active builders of knowledge.

The integration of outdoor laboratories into the Discovery Learning model provides a richer and more contextual dimension to learning. Outdoor laboratories utilize the natural environment around the school—such as parks, gardens, rice fields, rivers, or green open spaces—as natural laboratories, providing real objects and phenomena to observe and study (Yunita & Irawan, 2025). Using outdoor laboratories as a learning medium provides students with the opportunity to directly observe the characteristics of living things in their natural habitat, such as plants respiration through stomata, animals moving and responding to stimuli, and the visible differences between living and non-living things around them. This kind of hands-on experience not only strengthens conceptual understanding but also improves students' scientific skills holistically (Ekantini et al., 2017; Fitriyanti, 2021; Oktradiksa et al., 2021).

Various previous studies have demonstrated the effectiveness of this approach. Research by Mardia et al. (2025) showed that the use of outdoor laboratories significantly enhanced students' direct experience with natural objects and phenomena, enabling them to understand the characteristics of living things contextually and meaningfully. Christian et al. (2024) also demonstrated that outdoor laboratory-based learning significantly improved students' conceptual understanding and scientific skills. Furthermore, Sundari et al. (2024) reported that discovery learning has been shown to motivate students to actively engage in the learning process and facilitate mastery of scientific

competencies. Bertiliya et al. (2021) demonstrated through their meta-analysis that outdoor inquiry-based learning significantly contributes to improving students' scientific literacy at various levels of education.

The novelty of this research lies in the integration of the Discovery Learning model with an outdoor laboratory approach into a single, comprehensive, systematic, and validated learning product, which simultaneously targets the improvement of two crucial competencies—scientific literacy and science process skills—in the context of Islamic junior high schools. Previous research generally examines the effectiveness of discovery learning or outdoor learning separately, but few have integrated the two into a single learning product scientifically developed using a structured development model (Handayani et al., 2018; Hasbullah, 2016; Yew & Goh, 2016).

Based on an in-depth study of the existing problems and potential solutions offered by the outdoor laboratory-based Discovery Learning model, this study formulated two main objectives, namely: (1) developing a valid, practical, and effective outdoor laboratory-based Discovery Learning model on the material of characteristics of living things at MTsN 3 Banda Aceh, and (2) describing the level of scientific literacy and science process skills of students after using the developed model product. The results of this study are expected to provide a real contribution to the development of the quality of science learning, especially at the madrasah level, as well as being a reference for educators who want to implement an innovative and contextual environment-based learning approach.

Method

This study used the Research and Development (R&D) method with the 4D development model consisting of four stages, namely Define, Design, Develop, and Disseminate (Thiagarajan et al., 1974; Gormally et al., 2012). The Define stage was carried out through student analysis, problem analysis, task analysis, and needs analysis, with instruments such as science teacher interviews and learning observation sheets. The Design stage included format selection and product design of the outdoor laboratory-based Discovery Learning model, which included learning model guides, outdoor activity-based Student Worksheets (LKPD), and assessment instruments (Duda et al., 2019). The Develop stage involved product validation by two material experts, two learning experts, and one language expert, followed by a limited trial on 20 seventh-grade students of MTsN 3 Aceh Besar. The Disseminate stage was a field trial on 34 seventh-grade students of MTsN 3 Banda Aceh using a one-group pretest-posttest design. Validity data were analyzed based on the percentage of validation scores referring to Sugiyono's criteria (2015) with a valid interval of 81%–100%; Practicality was analyzed from teacher and student responses referring to Riduwan's (2010) criteria with a strong interval of 80%–100%; and effectiveness was measured through the calculation of the N-gain score and the paired sample t-test with the help of SPSS, with the data first tested for normality using Shapiro-Wilk

Result and Discussion

Validity of Discovery Learning Model Products

Validation of the outdoor laboratory-based Discovery Learning model product was conducted by two subject matter experts and two learning experts. The subject matter experts' validation assessment covered four aspects: curriculum, material presentation, material completeness, and language. The learning experts' validation assessment covered aspects of curriculum, learning syntax, and syntax suitability with outdoor elements. The complete results are presented in Table 1 and visualized in Figure 1.

Figure 1. Graph of percentage validity of discovery learning model products

Table 1. Validation Results of Material Experts and Learning Experts

Validator	Assessment Aspects	Percentage	Category
Subject,Matter Expert I	Curriculum,Presentation, Completeness, Language	85.27%	Valid
Subject Matter Expert II	Curriculum, Presentation, Completeness, Language	85.00%	Valid
Learning Expert I	Curriculum, Syntax, Outdoor Suitability	84.00%	Valid
Learning Expert II	Curriculum, Syntax, Outdoor Suitability	86.00%	Valid

Based on Table 1 and Figure 1, all validators gave scores above 81%, thus categorizing the Discovery Learning model product as valid. This result aligns with Sugiyono's (2015) criteria, which defines the 81%–100% range as valid. The highest score was given by Learning Expert II (86%), indicating that the syntax of the developed Discovery Learning model is highly in line with the principles of outdoor-based learning. Input from the validators, including improvements to the student worksheet (LKPD), the addition of end-of-module reflection points, and an emphasis on safety instructions, has been revised and integrated into the final product.

Practicality of Discovery Learning Model Products

The practicality of the product was measured through teacher and student responses during the dissemination stage. The teacher responses were assessed by a science teacher at MTsN 3 Banda Aceh covering seven aspects, while the student responses were obtained from 34 grade VII-1 students covering four aspects. The results of the practicality assessment per aspect are visualized in Figure 2 and summarized in Table 2.

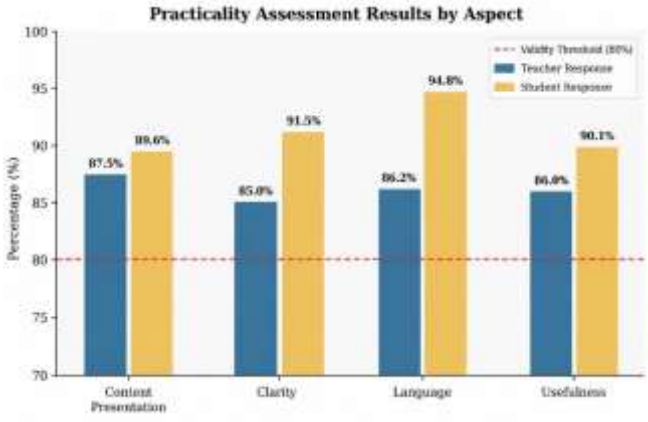

Figure 2. Practicality assessment graph per aspect (teacher and student responses)

Table 2. Results of the practicality assessment of the discovery learning model product

Respondents	Number of Grains	Percentage	Category
Teacher Response	32 grains	86.25%	Strong
Student Response (34 people)	15 grains	86.62%	Strong

Figure 2 shows that all aspects of teacher and student response assessments were above 80%, with the language aspect of student responses achieving the highest score (94.81%) and the student interest aspect reaching 91.48%. These values indicate that the outdoor laboratory-based Discovery Learning model was presented in easy-to-understand language and was able to significantly stimulate student learning interest. The results of teacher responses (86.25%) and students (86.62%) were in accordance with the criteria for Strong practicality according to Riduwan (2010), which is in the 80%–100% interval. This finding is in line with Agustini et al. (2025) who stated that the Discovery Learning model has the advantage of making it easier for students to obtain information directly from the environment, thereby increasing motivation and interest in learning (Drake et al., 2007).

Effectiveness of Outdoor Laboratory-Based Discovery Learning Model

The effectiveness of the Discovery Learning model was measured based on the pretest and posttest scores of class VII-1 students at MTsN 3 Banda Aceh (n=34). The comparison of pretest-posttest scores and N-gain scores is visualized in Figure 3, while the results of statistical calculations are presented in Table 3.

Figure 3 visually shows a very significant jump between the pretest (54.00) and posttest (84.48) scores, reflecting a 40.48% increase. The N-gain value of 0.73 is within the high criteria (N-gain > 0.70) as interpreted by Bisri et al. (2023). The Shapiro-Wilk normality test yielded significance values of 0.70 (pretest) and 0.65 (posttest), both of which were > 0.05, indicating a normal distribution of the data. Furthermore, the paired sample t-test yielded a significance value (2-tailed) of 0.000 < 0.05, proving a highly significant difference between learning outcomes before and after the implementation of the outdoor laboratory-based Discovery Learning model (Af'idayani et al., 2018; DeBoer, 2000; Haryono, 2006).

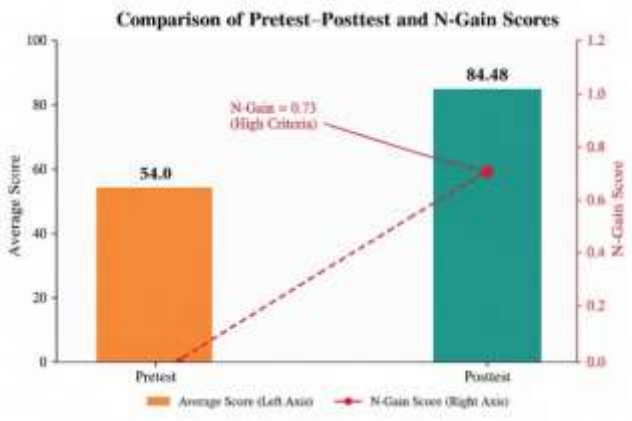

Figure 3. Comparison of pretest-posttest values and n-gain achievements

Table 3. Results of the Discovery Learning Model Effectiveness Test

Pretest Average	Posttest Average	Improvement	N-Gain	Sig. (2-tailed)	Criteria
54.00	84.48	40.48%	0.73	0.000	Tall

The success of this model is supported by the integration of the Discovery Learning syntax with scientific literacy indicators and the Science Learning Objectives (KPS). The problem-oriented syntax presented through videos of natural phenomena stimulates the "explaining scientific phenomena" aspect of scientific literacy. Student worksheets based on outdoor activities encourage students to directly identify, classify, observe, and evaluate objects, which are core science process skills. These findings reinforce the research findings of Bertiliya et al. (2021) who demonstrated the effectiveness of outdoor inquiry-based learning on scientific literacy, and Sun and Lin (2022) who reported significant improvements in scientific skills through outdoor discovery learning. Thus, the outdoor laboratory-based Discovery Learning model has proven to be a valid, practical, and highly effective learning innovation in improving students' scientific literacy and science process skills in the topic of the characteristics of living things.

Conclusion

Based on the results of research and development, it was concluded that: (1) The outdoor laboratory-based Discovery Learning Model on the material of characteristics of living things was developed through 4D stages producing products in the form of learning model guides and outdoor-based LKPD; (2) The product was declared valid based on the assessment of material experts (85.27% and 85%) and learning experts (84% and 86%); (3) The product was declared practical with teacher responses (86.25%) and students (86.62%) in the strong category; and (4) The product was proven to be very effective with an N-gain value of 0.73 (high criteria) and a T-test significance of 0.000 < 0.05. This model is recommended to be disseminated as a science learning innovation in MTs/SMP, and can be further developed on broader biology material or using other development models.

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Conceptualization, methodology, formal analysis, investigation, data curation, writing—original draft preparation, N. and J.; writing—review and editing, supervision, project administration, E.A., Y., and A.R. All authors have read and agreed to the published version of the manuscript.

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Conflict of Interest
All author declares no conflict of interest.

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