

Reimagining Science Education through *Tadabur Alam*: Integrating Experiential Outdoor Learning and Scientific Literacy for Transformative Learning

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Abstract

Science education needs to move beyond the transmission of scientific knowledge toward learning experiences that enable students to engage with real-world phenomena, construct meaning, and act responsibly. This article aims to formulate a transformative conceptual framework that positions *tadabur alam* as a paradigm for reimagining science education through the integration of Experiential Outdoor Learning and scientific literacy. This conceptual study employed library research using an analytical-critical and integrative approach. Literature on *tadabur alam*, experiential learning, outdoor learning, scientific literacy, and holistic learning was analyzed to synthesize the relationships among empirical experience, scientific inquiry, reflection, meaning-making, and responsible action. The synthesis indicates that Experiential Outdoor Learning provides authentic experiences and environmental contexts, while scientific literacy enables students to understand phenomena through observation, evidence, reasoning, and scientific explanation. *Tadabur alam* enriches these processes by connecting empirical experience with spiritual reflection, ecological awareness, and ethical responsibility. The proposed framework reorients science learning from understanding and explaining phenomena toward making meaning and using knowledge responsibly, providing a conceptual foundation for transformative learning.

Keywords: Experiential Outdoor Learning; science education; scientific literacy; *tadabur alam*; transformative learning

Membayangkan Ulang Pendidikan Sains melalui *Tadabur Alam*: Mengintegrasikan Pembelajaran Luar Ruang Berbasis Pengalaman dan Literasi Sains untuk Pembelajaran Transformatif

Abstrak

Pendidikan sains perlu melampaui transmisi pengetahuan ilmiah menuju pengalaman belajar yang memungkinkan peserta didik terlibat dengan fenomena dunia nyata, membangun makna, dan bertindak secara bertanggung jawab. Artikel ini bertujuan merumuskan kerangka konseptual transformatif yang menempatkan *tadabur alam* sebagai paradigma untuk membayangkan ulang pendidikan sains melalui integrasi Pembelajaran Luar Ruang Berbasis Pengalaman dan literasi sains. Studi konseptual ini menggunakan penelitian kepustakaan dengan pendekatan analitis-kritis dan integratif. Literatur tentang *tadabur alam*, pembelajaran berbasis pengalaman, pembelajaran luar ruang, literasi sains, dan pembelajaran holistik dianalisis untuk mensintesis hubungan antara pengalaman empiris, penyelidikan ilmiah, refleksi, pembentukan makna, dan tindakan bertanggung jawab. Sintesis menunjukkan bahwa Pembelajaran Luar Ruang Berbasis Pengalaman menyediakan pengalaman autentik dan konteks lingkungan, sedangkan literasi sains memungkinkan peserta didik memahami fenomena melalui observasi, bukti, penalaran, dan penjelasan ilmiah. *Tadabur alam* memperkaya proses tersebut dengan menghubungkan pengalaman empiris dengan refleksi spiritual, kesadaran ekologis, dan tanggung jawab etis. Kerangka yang diusulkan mengarahkan ulang pembelajaran sains dari memahami dan menjelaskan fenomena menuju menemukan makna dan

menggunakan pengetahuan secara bertanggung jawab, sehingga menyediakan landasan konseptual bagi pembelajaran transformatif.

Kata Kunci: Pembelajaran Luar Ruang Berbasis Pengalaman; pendidikan sains; literasi sains; *tadabur alam*; pembelajaran transformatif

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INTRODUCTION

The development of science and technology in the 21st century has coincided with increasingly complex global environmental challenges, including climate change, biodiversity loss, resource scarcity, and growing pressures on environmental sustainability. These challenges require individuals and communities not only to understand environmental issues but also to reason about them, consider their implications, and take actions that support sustainability (Ardoin et al., 2023). In this context, science education needs to move beyond the transmission of scientific knowledge toward learning that enables students to engage critically with real-world phenomena and use knowledge responsibly. Scientific literacy is therefore important not only for understanding scientific concepts but also for engaging in evidence-based reasoning, considering relevant information and values, and making decisions concerning real-world issues (Bossér, 2024; Lee, 2023). Such an orientation suggests the need to reimagine science learning as a process that connects scientific understanding with experience, meaning-making, and responsible action.

However, in certain biology learning contexts, instruction may still rely on conventional practices that emphasize teacher explanations, textbook use, and limited opportunities for students to investigate authentic environmental issues. Such conditions may constrain the connection between concepts learned in the classroom and students' real-world environmental experiences (Yasma et al., 2026). Learning experiences that directly engage students with phenomena and real-life contexts can help them connect scientific concepts with everyday experiences while promoting active engagement, critical thinking, problem-solving, and the application of knowledge (Acut, 2024). Similarly, learning designs based on Education for Sustainable Development place students at the center of learning, position the environment as a learning resource, and connect local and global issues as important principles for developing scientific literacy (Dieni et al., 2022). These findings suggest that science learning needs to provide more than conceptual understanding by creating opportunities for students to experience, investigate, reflect on, and apply knowledge in meaningful contexts.

One pedagogical approach that can support this reorientation is Experiential Outdoor Learning. Experiential learning provides students with opportunities to engage actively in learning through exploration, application of knowledge, and the development of understanding based on their experience (Wang et al., 2025). When such experiences take place outdoors, the real environment can serve as a learning resource, enabling students to interact directly with the objects and phenomena under study, make observations, ask questions, and connect concepts with environmental conditions (Tuga et al., 2025; Usman & Faradina, 2025). Outdoor experiences can also provide meaningful contexts for science learning; in botanical learning, integrating outdoor activities with meaningful learning enables students to identify plants in authentic settings and collaboratively construct their understanding (Parsazadeh & Cheng, 2025). Thus, Experiential Outdoor Learning can provide an important pedagogical pathway for connecting direct experience, observation, inquiry, reflection, and meaning-making, enabling scientific knowledge to be understood in relation to real-world phenomena and environmental contexts.

From an Islamic perspective, nature is not merely regarded as an object to be observed and utilized, but also as part of Allah's creation that contains signs of His greatness and can lead human beings to recognize the Creator. The Qur'an encourages people to observe and contemplate the creation of the heavens and the earth, as illustrated in Surah Ali 'Imran 3:190–191, which describes *ulul albab* as those who remember Allah while reflecting on the creation of the heavens and the earth. This perspective is closely related to the concept of *tadabur alam*, which refers to the process of contemplating, reflecting upon, and appreciating Allah's creation, so that observation of nature extends beyond recognizing phenomena toward awareness of the greatness and oneness of Allah ([Hardinagoro et al., 2024](#)). In education, *tadabur alam* can provide a learning experience that connects interaction with nature, the development of Islamic values, and environmental awareness ([Arifin, 2024](#); [Hasanah et al., 2024](#)). Thus, in science learning, *tadabur alam* has the potential to provide a foundation for connecting scientific inquiry with spiritual reflection, positioning nature simultaneously as a source of learning experience, an object of inquiry, and a space for developing awareness of Allah's greatness and human responsibility for sustaining life.

Although research on Experiential Outdoor Learning, scientific literacy, and value-based education has continued to develop, these perspectives tend to be addressed within separate areas of inquiry. Studies on Experiential Outdoor Learning have primarily emphasized direct experience, student engagement with the environment, and learning outcomes ([Parsazadeh & Cheng, 2025](#); [Tuga et al., 2025](#); [Usman & Faradina, 2025](#)), whereas studies on *tadabur alam* have focused more on the relationship between humans and nature within spiritual and Islamic education perspectives ([Hardinagoro et al., 2024](#); [Hasanah et al., 2024](#)). Although these perspectives offer complementary contributions, limited conceptual attention has been given to how they can be integrated to reorient science learning toward a transformative process that connects empirical inquiry, scientific reasoning, spiritual meaning-making, ecological awareness, and responsible action. Therefore, this article aims to develop a conceptual framework that positions *tadabur alam* as a paradigm for reimagining science education through the integration of Experiential Outdoor Learning and scientific literacy. The framework is expected to provide a conceptual basis for transformative science learning that connects ways of knowing, ways of making meaning, and ways of acting responsibly.

METHOD

This article employed library research using an analytical-critical and integrative approach. The authors conducted a literature review of various sources addressing *tadabur alam* from an Islamic perspective, Experiential Outdoor Learning, scientific literacy, experiential learning, and related approaches to meaningful and transformative science learning. The literature reviewed included relevant national and international scientific articles as well as Islamic sources used to understand the conceptual foundations of *tadabur alam* and the relationship between humans and nature.

The literature was subsequently analyzed descriptively and critically to identify the meaning, characteristics, relationships, and contributions of each perspective to science learning. The analysis focused on the relationships among direct experience in the environment, observation and scientific inquiry, reflection, scientific literacy, spiritual meaning-making, ecological awareness, and responsible action. The concepts were compared and elaborated to identify points of convergence between experiential learning approaches and the perspective of *tadabur alam*.

The results of the analysis were then integrated to formulate a conceptual framework that positions *tadabur alam* as a paradigm for reimagining science education through the integration of Experiential Outdoor Learning and scientific literacy. The synthesis was used to explain how empirical

experience, scientific inquiry, reflection, meaning-making, and responsible action can be connected within a transformative learning process.

RESULTS AND DISCUSSION

The Nature of Tadabur Alam from an Islamic Perspective

From an Islamic perspective, nature is Allah's creation as well as a collection of signs (*ayat kauniyah*) that guide human beings toward recognizing His greatness and oneness. The Qur'an encourages people to observe and reflect upon the creation of the heavens and the earth, as illustrated in Surah Ali 'Imran 3:190–191. The acts of observing, contemplating, and reflecting upon Allah's creation form an important basis for *tadabur alam*, which refers to the process of understanding and appreciating natural phenomena so that observation goes beyond what is empirically visible and leads to an awareness of the Creator ([Hardinagoro et al., 2024](#)).

Tadabur has both intellectual and reflective dimensions. It involves not only understanding an object or phenomenon, but also connecting that understanding with meanings and insights that can be derived for life. In the educational context, the concept of tadabur can encourage more analytical and reflective learning because students are guided beyond textual understanding to connect knowledge with experience and broader meanings ([Aulia et al., 2024](#)). Thus, *tadabur alam* can be understood as a reflective process that brings together observation of nature and reflection on the signs of Allah's greatness.

In education, *tadabur alam* also has the potential to strengthen the relationship between humans and nature while instilling Islamic values. Interaction with nature can become a learning experience that connects direct experience, awareness of Allah's creation, and the development of Islamic values ([Hasanah et al., 2024](#)). In science learning, this perspective extends the meaning of observing and investigating nature: scientific processes remain essential for obtaining and analyzing evidence, while tadabur provides space to reflect on meaning, order, and human responsibility for life. This reflective and meaning-making dimension provides a conceptual basis for reorienting science learning beyond the acquisition of knowledge toward deeper understanding, personal meaning, and responsible engagement with the world.

Tadabur Alam and the Development of Scientific Literacy

Scientific literacy is not limited to mastery of concepts but also involves the ability to use scientific knowledge and processes to understand phenomena and respond to issues in everyday life. Developing these abilities requires learning experiences that enable students to engage with authentic phenomena, observe and interpret information, and use evidence to construct understanding. A conceptual study of field trips indicates that learning experiences in real-world environments have the potential to integrate knowledge, scientific processes, and scientific attitudes, thereby strengthening students' scientific literacy ([Patmawati et al., 2026](#)).

The relationship between environmental experience and scientific literacy is also supported by empirical research. [Amanda and Rahmi \(2024\)](#) found that the implementation of outdoor learning influenced students' scientific literacy in ecosystem-related learning. The outdoor activities in their study included environmental observations and the use of questions to assess students' understanding, while scientific literacy encompassed, among other aspects, the ability to explain phenomena scientifically, evaluate or design investigations, and interpret scientific data and evidence. Thus, real-world environments function not only as learning settings but also as contexts in which students can develop scientific practices through direct engagement with phenomena. This perspective converges with *tadabur alam*, particularly in the activities of observing, contemplating, and reflecting upon natural phenomena.

This perspective converges with *tadabur alam*, particularly in the activities of observing, contemplating, and reflecting upon natural phenomena. In environment-based learning, direct experience can encourage students to conduct structured observations, formulate questions, evaluate data, and develop evidence-based explanations, all of which are important components of scientific literacy ([Patmawati et al., 2026](#)). Research on scientific approaches implemented through outdoor study indicates that learning in real-world environments can be organized through stages of problem identification, field observation, data collection, analysis, conclusion drawing, communication of findings, and reflection ([Manek et al., 2025](#)). Within the framework of *tadabur alam*, these processes can be extended through reflection on the order and uniqueness of Allah's creation and consideration of human beings' position and responsibility toward nature.

Thus, *tadabur alam* and scientific literacy have a complementary relationship. Scientific literacy provides an epistemic framework for understanding natural phenomena through observation, evidence, reasoning, and scientific explanation, whereas *tadabur alam* provides a reflective, spiritual, and ethical dimension to such experiences. Their integration enables science learning to move beyond understanding phenomena toward reflection on their meaning and the development of responsible decisions and actions. This movement from scientific understanding toward meaning-making and responsible action provides an important foundation for transformative science learning, in which changes in students' understanding, attitudes, and actions become part of the learning process ([Henukh et al., 2024](#)).

Experiential Outdoor Learning as a Pedagogical Space for Tadabur Alam

Experiential Outdoor Learning provides a pedagogical space in which students can construct understanding through direct experience, active engagement, and interaction with real environments. In science education, such experiences enable students to connect scientific concepts with natural phenomena encountered directly, making learning more contextual and meaningful. A systematic review of experiential learning in science education indicates that experiential approaches can support learning outcomes, motivation, curiosity, and students' competencies ([Susiloningsih et al., 2023](#)). Outdoor learning also enables the environment to function as a learning resource, although its implementation requires adequate pedagogical preparation and institutional support ([Klopčič & Torkar, 2026](#)). Through direct observation, exploration, data collection, and interaction with natural phenomena, Experiential Outdoor Learning therefore provides an experiential foundation for learning that connects scientific knowledge with real-world contexts.

The experiential dimension of outdoor learning becomes more meaningful when students are given opportunities to reflect on what they have experienced and connect it with their existing understanding. [Nurhayati et al. \(2023\)](#) emphasize the contribution of reflective thinking to transformative science learning, particularly in enabling students to connect new ideas with real-life experiences, reconsider their understanding, and develop deeper insights. Similarly, [Funa et al. \(2023\)](#) describe transformative pedagogy as an approach that encourages learners to evaluate and modify their perspectives and actions, while action-oriented learning connects direct experience, observation, reflection, conceptual development, and the application of knowledge in new situations. These perspectives suggest that outdoor experience alone does not necessarily produce transformation; its transformative potential emerges when experience is processed through reflection, meaning-making, and the application of newly developed understanding.

Within this framework, Experiential Outdoor Learning provides a pedagogical space for integrating *tadabur alam* into science learning. Direct encounters with natural objects and phenomena create opportunities for students to observe, investigate, and construct scientific understanding, while

reflection provides space to contemplate the order, diversity, uniqueness, and interconnectedness of creation. In the perspective of *tadabur alam*, such reflection can extend empirical understanding toward spiritual meaning and awareness of human responsibility toward nature. Thus, Experiential Outdoor Learning and *tadabur alam* can be connected through a learning process that moves from direct experience and scientific inquiry to reflection, meaning-making, and responsible action. In this sense, the outdoor environment is not merely a location for conducting science activities but a pedagogical space in which scientific understanding, personal meaning, spiritual awareness, and responsible engagement with the environment can be developed together.

Integration of Tadabur Alam, Experiential Outdoor Learning, and Scientific Literacy

The integration of these three perspectives provides a conceptual foundation for science learning that connects spiritual reflection, direct experience in nature, and the development of scientific skills within a unified pedagogical process (Fan et al., 2024; Harahap et al., 2026; Raida et al., 2025). Experiential Outdoor Learning provides a pedagogical context in which students can interact directly with natural objects and phenomena. Such experiences can serve as a starting point for developing scientific literacy through activities such as observing, identifying phenomena, formulating questions, gathering information or evidence, analyzing data, and constructing explanations based on inquiry findings. At the same time, direct experiences with nature provide opportunities for students to reflect on what they observe and learn. Thus, Experiential Outdoor Learning functions not merely as a strategy for moving learning beyond the classroom, but as an experiential space in which scientific processes, reflection, and meaning-making can take place in contextual and meaningful ways.

Within the perspective of *tadabur alam*, these experiences acquire an additional layer of meaning. Phenomena observed through scientific processes are understood not only in terms of empirical cause-and-effect relationships but can also be reflected upon as manifestations of the order and diversity of Allah's creation. This perspective connects empirical observation, rational reasoning, and spiritual internalization in understanding nature (Putra et al., 2025; Rosyid & Suhayati, 2025). In this sense, *tadabur alam* does not replace scientific inquiry; rather, it serves as a reflective dimension that complements the processes of acquiring and understanding knowledge. Scientific literacy provides an epistemic basis for understanding phenomena through data, evidence, and reasoning, whereas *tadabur alam* provides space to interpret these experiences within spiritual and ethical dimensions. The complementary functions of these three perspectives are summarized in Table 1.

Tabel 1. Integration of *Tadabur Alam*, Experiential Outdoor Learning, and Scientific Literacy for Transformative Science Learning

Perspective	Core Function	Key Learning Processes	Contribution to Transformative Learning
Experiential Outdoor Learning	Provides authentic experiences and environmental contexts	Observation, exploration, and real interaction, investigation	Connects scientific concepts with direct and meaningful experiences
Scientific Literacy	Provides an evidence-based framework for understanding phenomena	Questioning, gathering, interpretation, and scientific explanation	Develop scientific reasoning and informed decision-making
Tadabur Alam	Provides spiritual, reflective, and ethical orientation	Contemplation, reflection, meaning-making, and awareness of responsibility	Connects scientific understanding with spiritual and ecological meaning

Integration	Connects experience, inquiry, reflection, and meaning	Experience, inquiry, reflection, meaning-making, and responsible action	scientificReorients learning from knowledge acquisition toward meaningful understanding and responsible action	awareness, and ethical responsibility
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Table 1 shows that the three perspectives have distinct but complementary functions. Experiential Outdoor Learning provides authentic experiences and real-world contexts; scientific literacy provides an evidence-based framework for understanding phenomena through observation, evidence, reasoning, and scientific explanation; while *tadabur alam* provides a spiritual, reflective, and ethical orientation for interpreting those experiences. Their integration connects experience, scientific inquiry, reflection, and meaning-making within a unified learning process. This connection enables students not only to understand natural phenomena but also to reflect on their experiences, derive broader meaning, and consider how scientific knowledge can be used responsibly.

Based on the synthesis of the literature, this integrated process can be understood as a pathway toward transformative science learning. Students begin with direct experiences and scientific inquiry, process their findings through evidence-based reasoning, and then engage in reflection and meaning-making through *tadabur alam*. These processes can contribute to changes in how students understand phenomena, interpret their relationship with nature, and consider their responsibilities toward life and the environment. The resulting understanding can be translated into informed decisions and responsible actions. Thus, the integration of *tadabur alam*, Experiential Outdoor Learning, and scientific literacy provides a conceptual foundation for reorienting science learning from knowledge acquisition toward meaningful understanding and responsible engagement with the world.

Tadabur Alam as a Paradigm for Transformative Learning

Transformative learning in science education extends the purpose of learning beyond the acquisition and application of scientific knowledge toward changes in how learners understand phenomena, develop perspectives, and respond to real-world situations. [Henukh et al. \(2024\)](#), through a bibliometric analysis of transformative learning in science education, describe transformative science learning as an approach oriented toward changes in students' understanding, attitudes, and actions toward science. Their analysis also identifies connections between transformative science learning and environmental education, sustainability education, critical thinking, creativity, and sustainable development. This perspective positions science learning as a process in which students can reconsider their understanding of scientific phenomena and their relationship with real-world issues.

Reflection is an important process through which experiences can contribute to transformative learning. [Nurhayati et al. \(2023\)](#) highlight the contribution of reflective thinking to transformative science learning, particularly in enabling students to connect new ideas with real-life experiences, reconsider their understanding, and develop deeper insights. Their synthesis indicates that reflective thinking can support students in connecting learning concepts with experience, solving problems, and developing deeper understanding. In this sense, reflection enables learners to move beyond simply experiencing or acquiring information toward reconsidering the meaning of their experiences and constructing new understanding.

The transformative potential of this process is further supported by learner-centered and action-oriented approaches. [Funa et al. \(2023\)](#) describe transformative pedagogy as an approach that encourages learners to evaluate and modify their perspectives and actions, while action-oriented learning connects direct experience, observation, reflection, conceptual development, and the application of knowledge in

new situations. In the context of *tadabur alam*, this process can be extended by connecting scientific understanding with spiritual meaning, ecological awareness, and ethical responsibility. Direct encounters with nature provide the experience, scientific literacy provides the means to understand phenomena through evidence and reasoning, and *tadabur alam* provides space for reflection and meaning-making. The resulting process can reorient learners from merely knowing and explaining natural phenomena toward understanding their meaning, recognizing their relationship with nature and the Creator, and using knowledge through responsible action. Thus, *tadabur alam* can be positioned as a paradigm that gives transformative direction to science learning.

Conceptual Framework of Tadabur Alam as a Paradigm for Holistic Learning

The conceptual synthesis presented in this article positions *tadabur alam* as a paradigm that provides meaning and direction to learning experiences in nature. As illustrated in Figure 1, *tadabur alam*, Experiential Outdoor Learning, and scientific literacy have complementary roles within the proposed framework. *Tadabur alam* provides reflective, spiritual, and ethical dimensions; Experiential Outdoor Learning provides direct and authentic experiences in natural environments; and scientific literacy provides the epistemic basis for understanding phenomena through observation, evidence, reasoning, and scientific explanation. Their integration creates a learning process that connects empirical experience, scientific inquiry, reflection, meaning-making, and responsible action.

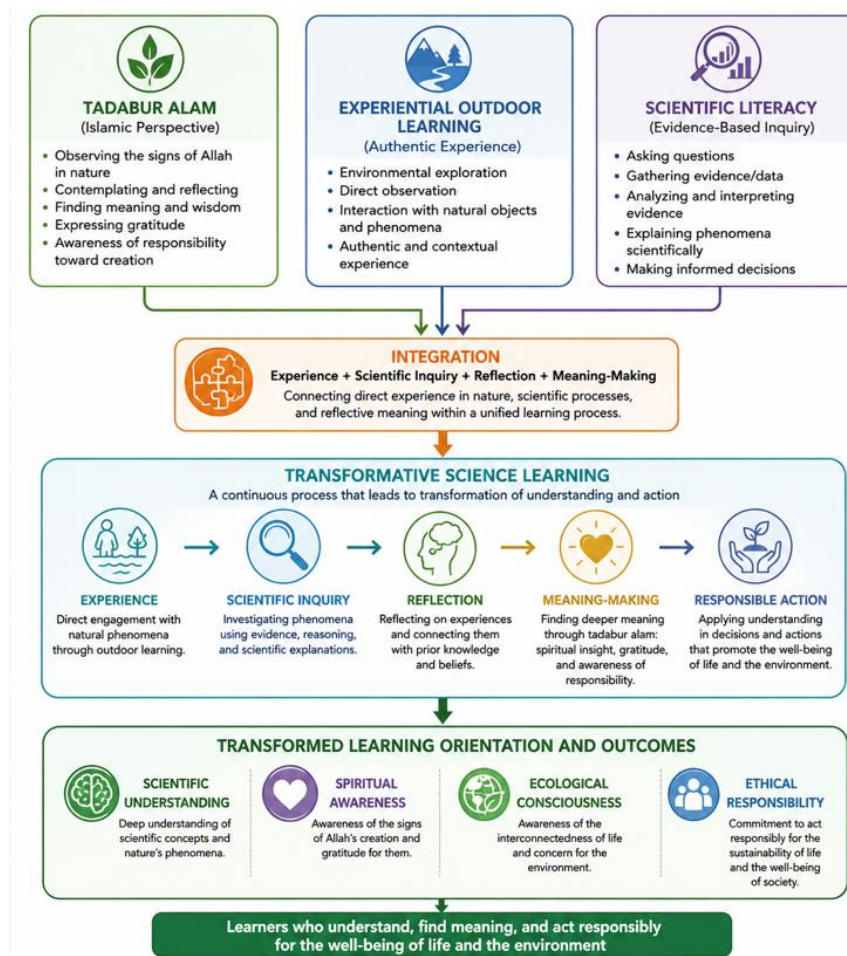


Figure 1. Conceptual framework of *tadabur alam* as a paradigm for transformative science learning through the integration of Experiential Outdoor Learning and scientific literacy

Figure 1 presents the conceptual framework of *tadabur alam* as a paradigm for transformative science learning through the integration of Experiential Outdoor Learning and scientific literacy. The framework brings together three complementary dimensions. *Tadabur alam* provides an Islamic foundation for meaning and value through observing nature as a sign of Allah's creation, contemplation, reflection, meaning-making, gratitude, and awareness of responsibility. Experiential Outdoor Learning provides authentic and contextual experiences through direct engagement with natural environments, exploration, observation, and interaction with natural objects and phenomena. Meanwhile, scientific literacy provides an evidence-based inquiry process through questioning, gathering and interpreting evidence, explaining phenomena scientifically, and making informed decisions.

The integration of these three dimensions connects experience, scientific inquiry, reflection, and meaning-making within a unified learning process. In this framework, direct experiences in nature become the starting point for scientific inquiry, while scientific reasoning provides a means of understanding the phenomena encountered. The experiences and findings are then processed through reflection and *tadabur alam*, allowing students to connect scientific understanding with deeper meaning, spiritual awareness, and recognition of their responsibility toward nature. Thus, the framework does not position spiritual reflection as separate from scientific inquiry; rather, reflection and meaning-making are integrated into the process of learning from and about nature.

The integrated process is conceptualized as transformative science learning, represented in Figure 1 through the interconnected stages of understanding phenomena, reflection, meaning-making, awareness, and responsible action. This orientation is consistent with the growing emphasis on transformative learning in science education, which extends science learning beyond knowledge acquisition toward changes in understanding, perspectives, and actions ([Henukh et al., 2024](#)). Reflective thinking is particularly important because it can facilitate transformative science learning by enabling learners to connect new ideas with experiences, reconsider their understanding, and develop deeper insights ([Nurhayati et al., 2023](#)). Similarly, learner-centered, action-oriented, and transformative learning emphasizes direct experience, observation, reflection, conceptual development, and the application of knowledge in new situations ([Funa et al., 2023](#)).

The final component of the framework is the development of transformed learners characterized by scientific understanding, spiritual awareness, ecological consciousness, and ethical responsibility. These outcomes represent the broader orientation of the proposed framework: learners are expected not only to understand natural phenomena scientifically, but also to find meaning in their experiences, recognize the interconnectedness of life, and use knowledge responsibly. In this sense, *tadabur alam* functions not as an additional religious element introduced after science learning, but as a paradigm that provides meaning and direction throughout the learning process. The framework therefore offers a conceptual basis for reimagining science education as a transformative process that connects how learners understand phenomena, how they make meaning of their experiences, and how they act responsibly toward nature and life.

Pedagogical implications

The conceptual framework of *tadabur alam* as a paradigm for transformative science learning has several pedagogical implications for the design and implementation of science education. Learning needs to connect direct experiences in nature, scientific inquiry, reflection, meaning-making, and responsible action. Teachers therefore have a role not merely as providers of information but as facilitators who design meaningful learning experiences and guide students in connecting observations with scientific concepts and broader meanings. Learning can begin by presenting natural phenomena or environmental issues

that are relevant to students' lives, followed by the formulation of questions and observation objectives. This initial stage is important for developing awareness, curiosity, and readiness before students engage directly with the environment.

During Experiential Outdoor Learning activities, students can interact directly with natural objects and phenomena through observation, exploration, data collection, documentation, and simple investigations. Teachers can guide students to use evidence to explain phenomena, compare observations, and relate findings to scientific concepts. At this stage, the environment functions both as a source of experience and as a source of evidence that supports the development of scientific literacy. Learning activities can be adapted to the characteristics of the subject, such as investigating plant diversity, organism structure and function, ecosystem interactions, environmental quality, or changes in the surrounding environment. Such experiences provide a meaningful context in which students can construct scientific understanding through direct engagement with real-world phenomena.

Following outdoor activities, learning needs to continue through reflection and *tadabur alam*. Students can discuss their observations, interpret data, evaluate the explanations developed, and relate their findings to scientific concepts. Teachers can then provide opportunities for students to contemplate the order, uniqueness, diversity, and interconnectedness of the observed phenomena as part of Allah's creation. Reflection can be guided through questions concerning what has been learned, what meaning can be derived from the experience, how humans are related to nature, and what responsibilities arise from the knowledge gained. In this process, reflection serves not only to strengthen cognitive understanding but also to facilitate meaning-making, spiritual awareness, ecological consciousness, and reconsideration of students' relationship with the natural world.

At the final stage, learning experiences and reflections can be translated into responsible action. Students may develop simple solutions, undertake conservation activities, design environmental campaigns, produce educational materials, or engage in other actions relevant to the problems they have identified. This process extends learning beyond knowledge acquisition and reflection toward the application of knowledge in meaningful contexts. In this sense, the implementation of *tadabur alam* through Experiential Outdoor Learning can support a transformative learning orientation in which students develop scientific understanding while also constructing meaning, strengthening spiritual and ecological awareness, and taking responsible action. The pedagogical process therefore connects scientific knowledge, authentic experience, reflection, and ethical action toward the development of learners who are scientifically informed, spiritually aware, ecologically conscious, and responsible.

CONCLUSION

Based on the conceptual synthesis, *tadabur alam* can be positioned as a paradigm for transformative science learning that connects empirical experience, scientific inquiry, spiritual reflection, meaning-making, and responsible action. The integration of *tadabur alam*, Experiential Outdoor Learning, and scientific literacy demonstrates that nature can function not only as an object and source of scientific knowledge but also as a space for authentic experience, reflection, and meaning-making. Experiential Outdoor Learning provides direct engagement with the natural environment, scientific literacy provides an evidence-based framework for understanding phenomena through observation, evidence, and reasoning, while *tadabur alam* provides a reflective, spiritual, and ethical dimension to these experiences. Together, these perspectives establish a learning process that connects how learners understand phenomena, how they make meaning of their experiences, and how they use knowledge responsibly.

The proposed conceptual framework repositions *tadabur alam* not as an additional religious value introduced after science learning, but as a paradigm that provides meaning and direction throughout the

learning process. The integration of direct experience, scientific inquiry, reflection, and meaning-making can support a transformative orientation in science education, in which learning extends beyond knowledge acquisition toward deeper understanding, changed perspectives, spiritual and ecological awareness, and responsible action. As a conceptual framework, this approach provides a foundation for reimagining science education and for developing and empirically examining *tadabur alam* based transformative learning designs across diverse science education contexts.

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REFERENCES

- Acut, D. P. (2024). From classroom learning to real-world skills: An autoethnographic account of school field trips and STEM work immersion program management. *Disciplinary and Interdisciplinary Science Education Research*, 6(1), 20. <https://doi.org/10.1186/s43031-024-00111-x>
- Amanda, A. V., & Rahmi, L. (2024). Pengaruh metode outdoor learning terhadap literasi sains materi ekosistem siswa sekolah dasar. *Innovative: Journal Of Social Science Research*, 4(3), 3106–3117. <https://doi.org/10.31004/innovative.v4i3.10809>
- Ardoin, N. M., Bowers, A. W., & Wheaton, M. (2023). Leveraging collective action and environmental literacy to address complex sustainability challenges. *Ambio*, 52(1), 30–44. <https://doi.org/10.1007/s13280-022-01764-6>
- Arifin, S. (2024). Islamic boarding school strategy in improving quality tadabbur nature based students. *Proceeding of International Conference on Education, Society and Humanity*, 2(1), 1155–1162. <https://ejournal.unuja.ac.id/index.php/icesh/article/view/7925>
- Aulia, M. H., Surahman, C., & Sumarna, E. (2024). Optimalisasi pendidikan dengan konsep tadabur: Telaah tafsir tarbawi atas QS. Muhammad [47]: 24. *Jurnal Semiotika-Q: Kajian Ilmu al-Quran dan Tafsir*, 4(2), 769–789. <https://doi.org/10.19109/jsq.v4i2.24937>
- Bossér, U. (2024). Transformation of school science practices to promote functional scientific literacy. *Research in Science Education*, 54, 265–281. <https://doi.org/10.1007/s11165-023-10138-1>
- Dieni, W. E. F., Hernani, H., & Kaniawati, I. (2022). Applying the education for sustainable development approach to energy instruction design for encouraging scientific literacy of junior high school students. *Jurnal Pendidikan MIPA*, 23(2), 670–680.
- Fan, M.-R., Tran, N.-H., Nguyen, L.-H.-P., & Huang, C.-F. (2024). Effects of outdoor education on elementary school students' perception of scientific literacy and learning motivation. *European Journal of Educational Research*, 13(3), 1353–1363. <https://doi.org/10.12973/eu-jer.13.3.1353>
- Funa, A. A., Gabay, R. A. E., Esdicul, K. L., & Prudente, M. S. (2023). Secondary teachers' and students' perceptions of distance education in science: Focus on learner-centered, action-oriented, and transformative learning. *Dalat University Journal of Science*, 156–181. [https://doi.org/10.37569/DalatUniversity.13.3.1108\(2023\)](https://doi.org/10.37569/DalatUniversity.13.3.1108(2023))

- Harahap, D. G. S., Irawan, F., Rafi'y, M., Lima, C. N. de, Riyana, M., & Sormin, S. A. (2026). Model pembelajaran outdoor learning berbasis lingkungan alam untuk mengembangkan literasi sains anak usia dini. *TEACHING: Jurnal Inovasi Keguruan Dan Ilmu Pendidikan*, 6(3), 1653–1665. <https://doi.org/10.51878/teaching.v6i3.12627>
- Hardinagoro, M. A., Sulthoni, A., & Wirastho, E. (2024). Tadabbur alam dalam al-quran (studi penafsiran ayat-ayat tadabbur alam dalam tafsir al-azhar). *Bunyan Al-Ulum : Jurnal Studi Islam*, 1(1), 1–18. <https://doi.org/10.58438/bunyanalulum.v1i1.235>
- Hasanah, I. F., Istiqomah, Hasanah, U., & Budiman, H. (2024). Connecting with nature: Tadabur alam and its effect on islamic value learning. *E3S Web of Conferences*, 482, 04020. <https://doi.org/10.1051/e3sconf/202448204020>
- Henukh, A., Setiawan, A., Rusdiana, D., Syukri, M., & Agustin, M. (2024). Transformative learning in science education: Bibliometric analysis. *Asian Journal of Science Education*, 6(2), 1–10. <https://doi.org/10.24815/ajse.v6i2.38511>
- Klopčič, M., & Torkar, G. (2026). Emerging themes of empirical research into outdoor science teaching: A systematic literature review. *Journal of Outdoor and Environmental Education*, 29(2), 741–763. <https://doi.org/10.1007/s42322-025-00215-6>
- Lee, A. (2023). The importance of cultivating awareness of environmental matters in science classrooms: A cross-regional study. *Australian Journal of Environmental Education*, 39(4), 467–491. <https://doi.org/10.1017/aee.2023.7>
- Manek, A. H., Pamungkas, B. T. T., Andrinata, A., Sunimbar, S., & Samin, M. (2025). Pengaruh pendekatan saintifik berbasis outdoor study terhadap kemampuan berpikir spasial peserta didik. *Jurnal Geografi*, 21(1), 1–13. <https://doi.org/10.35508/jgeo.v21i1.22301>
- Nurhayati, P., Widodo, A., & Syamsudin, A. (2023). The review of fundamental framework for reflective thinking and practice in science education: Implications for transformative science learning. *Journal of Innovative Science Education*, 12(3), 289–308. <https://doi.org/10.15294/jise.v12i3.78189>
- Parsazadeh, N., & Cheng, P.-Y. (2025). Meaningful mobile learning framework to improve learning performance of natural science students. *Journal of Educational Technology Systems*, 54(2), 452–476. <https://doi.org/10.1177/00472395251363636>
- Patmawati, K., Hariyadi, B., & Yusnaidar, Y. (2026). Penguatan literasi sains melalui field trip ekosistem lahan gambut: Perspektif konseptual: (strengthening scientific literacy through peatland ecosystem field trips: a conceptual perspective). *BIODIK*, 12(1), 194–201. <https://doi.org/10.22437/biodik.v12i1.51952>
- Putra, F. M. A., Anshari, A., & Irmawati, I. (2025). Integrasi nilai-nilai islam dalam pengembangan ilmu pengetahuan pada era society 5.0. *Media Riset Bisnis Manajemen Akuntansi*, 1(1), 106–113. <https://doi.org/10.71312/mrbima.v1i1.439>
- Raida, S. A., Ridlo, S., & Marianti, A. (2025). The TABS model: Integrating tadabbur alam, biomimicry, and STEAM to foster students' sustainability awareness and creative problem-solving skills. *Thabiea: Journal of Natural Science Teaching*, 8(2), 172–189. <https://doi.org/2010.21043/thabiea.v8i2.34572>
- Rosyid, N., & Suhayati, E. (2025). Implementation of the tadabur alam learning approach in increasing santri faith at TPQ nurud dzolam, sukasari village, pulosari district, pandeglang regency, banten. *Al-Afkar, Journal For Islamic Studies*, 8(1), 262–274. <https://doi.org/10.31943/afkarjournal.v8i1.1665>

- Susiloningsih, E., Sumantri, M. S., & Marini, A. (2023). Experiential learning model in science learning: Systematic literature review. *Jurnal Penelitian Pendidikan IPA*, 9(9), 550–557. <https://doi.org/10.29303/jppipa.v9i9.4452>
- Tuga, A. F. C., Kua, M. Y., Suparmi, N. W., & Laksana, D. N. L. (2025). The Effect of Outdoor Learning Methods to Improve Students' Understanding of Sciences at Elementary School. *Edunesia : Jurnal Ilmiah Pendidikan*, 6(1), 465–476. <https://doi.org/10.51276/edu.v6i1.1132>
- Usman, A., & Faradina. (2025). Efektivitas pembelajaran outdoor study terhadap pemahaman konsep IPA siswa kelas VII mts darul ulum kota Ternate. *KUANTUM: Jurnal Pembelajaran Dan Sains Fisika*, 6(2), 318–327. <https://doi.org/10.63976/kuantum.v6i2.1206>
- Wang, M., Zhu, J., Gu, H., Zhang, J., Wu, D., & Wang, P. (2025). Optimizing experiential learning in science education: The role of two-tier testing in digital game-based learning. *Entertainment Computing*, 54, 100960. <https://doi.org/10.1016/j.entcom.2025.100960>
- Yasma, Suwono, H., & Rahayu, S. E. (2026). Enhancing environmental literacy and argumentation skills: Developing a PjBL-based interactive e-module integrating local ecological issues. *Edubiotik : Jurnal Pendidikan, Biologi Dan Terapan*, 11(01), 13–28. <https://doi.org/10.33503/ebio.v11i01.2744>

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