Volume 4 Number 1 (2024)
January-June 2024
Page: 132-144

E-ISSN: 2797-0965
P-ISSN: 2809-9710
DOI: 10.37680/basica.v4i1.9506

BASICA Journal of Primary Education

Breathing Life into the Earth: Experience-Based Oxygen Education Through a Tree-Planting Initiative at Elementary Schools

Taufikin
Institut Agama Islam Negeri Kudus; Indonesia
Correspondence Email; taufikin@iainkudus.ac.id

Submitted: 12/04/2024 Revised: 28/04/2024 Accepted: 28/05/2024 Published: 28/06/2024

Abstract

Oxygen sustains life, yet in elementary education, it is often treated as an abstract concept detached from real-world experience. This study examines how understanding of oxygen is constructed through tree-planting activities. The approach used was a qualitative case study, with data collected through participant observation, in-depth interviews, and documentation from October to December 2023 in SD Negeri Harjowinangun 02 Dempet Demak. The results reveal a multi-layered transformation. On the cognitive dimension, students transitioned from a general understanding to recognising the cause-and-effect relationship between trees and oxygen. On the affective dimension, emotional engagement emerged in the form of ecological concern and empathy. On the social dimension, collective responsibility was fostered through collaborative practices and social control. These three dimensions are integrated into a single experience-based learning process. These findings confirm that concrete experiences serve as an epistemic bridge connecting scientific concepts with living ecological awareness. The novelty of this research lies in the development of oxygen-based ecological pedagogy as an integrative model that unites experience, reflection, emotion, and social practice. This model expands science learning toward contextual practice and strengthens sustainable environmental education.

Keywords

Ecological awareness; elementary school; environmental education; experiential learning ; oxygen education

INTRODUCTION

Climate change, environmental degradation, and declining air quality have become global issues that cannot be postponed (Cohen et al., 2017; Lelieveld et al., 2015). Reports confirm that human activities are accelerating the ecological crisis, with direct consequences for health and the sustainability of life (Masson-Delmotte et al., 2021). In this context, oxygen is not merely a chemical element, but the existential foundation of human life. However, a paradox arises in elementary education. Oxygen is taught as a cognitive concept detached from its ecological reality. Yet, education plays a strategic role in fostering environmental awareness from an early age (Ardoin & Bowers, 2020; Stevenson et al., 2020). Global pressure for sustainable education is growing stronger, particularly since the launch of the Education for Sustainable Development agenda (Adipat & Chotikapanich, 2022; Shulla et al., 2020). At this juncture, elementary schools serve as the initial setting for shaping the relationship between humans and the environment.

Several recent studies have examined environmental education from various perspectives. A study by Carfora et al. (2017) highlights the importance of emotional connections with nature in shaping pro-environmental behaviour. Van der Linden (2019) emphasises that direct experiences in nature contribute to the formation of sustainability values. Meanwhile, Komonkanjanakul & Supapongpichate (2022) and Schneller et al. (2022) examine the outcomes of environmental education within the framework of community-based learning. Talebpour et al. (2020), Sharma-Brymer et al. (2018) and Fyfe-Johnson et al. (2021) expanded the discourse by positioning nature connection as part of early childhood development.

On the other hand, research by Stevenson et al. (2020) indicates that the integration of environmental education into the formal curriculum remains fragmented. Generally, these studies focus on ecological awareness, nature connectedness, and environmental behaviour. Yet, they remain limited in their ability to link specific scientific concepts, such as oxygen, to concrete learning experiences. Existing studies predominantly examine environmental awareness and nature connectedness, while paying limited attention to the epistemic transformation of abstract scientific concepts through lived experience.

Theoretically, experience-based learning is rooted in the experiential learning theory developed by Kolb (2012; 1984), which emphasises a cycle of concrete experience, reflection, conceptualisation, and active experimentation. In the context of environmental education, this theory is reinforced by the concept of ecological literacy, which views humans as part of the web of

life (Clavin, 2014; Pitman et al., 2018; Sigit et al., 2023). Furthermore, Wilson's biophilia theory asserts an inherent human tendency to connect with nature (Barbiero, 2023; Kaplan & Kaplan, 1989; Wilson, 1984). However, the application of these theories in the context of elementary education often remains at the conceptual level. The integration of specific scientific concepts, direct experiences, and the formation of values has yet to be systematically established.

However, there is a significant gap in the existing literature. Empirical studies that explicitly examine how elementary school students construct their understanding of oxygen through direct ecological engagement remain limited. Little is known about how abstract scientific concepts, such as oxygen, can be internalised through experiential environmental practices such as tree planting. Previous research has not sufficiently addressed the integration of science literacy and ecological practices within the context of elementary education. Furthermore, most studies remain dominated by quantitative approaches that emphasise the measurement of attitudes, without delving deeply into the processes of meaning-making. Local contexts, particularly elementary schools in Indonesia with their distinctive social and cultural characteristics, have also rarely been empirically explored. Therefore, this study is important to fill this gap.

This study aims to examine how elementary school students' understanding of oxygen is developed through the experience of planting trees. Specifically, this study addresses the following questions: (1) how students interpret oxygen before and after the tree-planting activity; (2) how this experiential process shapes cognitive, affective, and social dimensions; and (3) how this practice contributes to environmental awareness. This study employs a qualitative case study design conducted at SD Negeri Harjowinangun 02, Dempet, Demak. Theoretically, this study contributes to the development of the concept of "oxygen-based ecological pedagogy" as an integrative approach. In practice, this study offers a model of context-based, environment-centred learning. Socially, this study promotes the development of a more ecologically conscious generation.

METHOD

This study employs a qualitative case study design (Creswell & Creswell, 2022; de Vries, 2020). This design was chosen because it allows the researcher to gain an in-depth understanding of the process of constructing meaning regarding oxygen within the context of students' real-life experiences. Case studies provide space to capture the dynamics of interaction among knowledge, experience, and values in specific, contextual situations (Creswell & Poth, 2017; Yin, 2014). This

approach aligns with the research objective, which is not oriented toward statistical generalisation but toward depth of understanding and richness of meaning.

The research was conducted at Harjowinangun 02 Public Elementary School, Dempet Subdistrict, Demak Regency, Central Java. This school is located in a semi-rural setting with a community that still maintains close ties to agricultural activities. The selection of the location was based on the contextual relevance between environmental issues and the students' daily lives. Additionally, the school is active in environment-based activities, thereby providing an adequate empirical space to examine the integration of oxygen education through tree-planting practices.

The study participants consisted of 35 fourth- and fifth-grade students and 3 supervising teachers. Participants were selected using purposive sampling based on the following criteria: (1) students directly involved in tree-planting activities, (2) teachers supervising the activities, and (3) willingness to participate in the study. The students were aged 9–11 years, which, in terms of cognitive development, corresponds to the concrete operational stage (Piaget, 1972). Primary data were derived from students' experiences, while supplementary data were obtained from teachers and activity documentation.

Data were collected from October to December 2023 using three primary techniques: participant observation, in-depth interviews, and documentation (Bowen, 2009; Knott et al., 2022; Ponticell et al., 2018). Participant observation involved the researcher's direct engagement in the tree-planting activities. The researcher recorded students' interactions, expressions, and behaviours throughout the process. Semi-structured interviews were conducted with students and teachers to explore their understanding, experiences, and reflections. Sample questions included: "Where does oxygen come from?" and "How did you feel after planting a tree?" Documentation in the form of activity photos, field notes, and school records was used to strengthen the data's validity.

Data analysis was conducted using thematic analysis. The analysis process followed these steps: (1) initial coding to identify units of meaning, (2) categorisation to group similar themes, and (3) interpretation to construct a conceptual narrative (Braun & Clarke, 2006, 2019). The analysis was conducted iteratively by comparing data across sources. This process enabled the emergence of key themes, including cognitive understanding, affective engagement, and social awareness

.

FINDINGS AND DISCUSSION

Findings

The Transformation of Understanding Oxygen: From Abstract Concept to Real-Life Experience

The first finding indicates a fundamental shift in how students understand oxygen. Before the activity, oxygen was perceived as something invisible and associated only with breathing. After the tree-planting activity, this understanding expanded. Students began to associate oxygen with trees as its primary source. Cause-and-effect relationships began to take shape more concretely.

Table 1. Transformation of Oxygen Understanding

Data Source	Quote / Finding	Frequency	Interpretation
Student 1	"Oxygen comes from trees; without trees, we would have difficulty breathing."	High	Cause-and-effect relationship begins to be understood
Student 2	"I used to think oxygen was just ordinary air."	Medium	Shift from general to specific understanding
Teacher 1	"Students are starting to connect trees with their lives."	High	Concept internalization
Observation	Students mention the function of trees during activities	High	Contextual understanding
Documentation	Students' reflective notes about trees	Medium	Written cognitive evidence

Source: Thematic analysis data by the researcher

Table 1 illustrates a reconstruction of the meaning of oxygen, shifting from a superficial understanding toward a relational one. In the initial phase, oxygen was perceived as "ordinary air," with no clear source. However, after the tree-planting experience, students began to construct concrete cause-and-effect relationships. The statement "oxygen comes from trees" marks the emergence of an ecological awareness that is no longer abstract. Findings from teachers and observations reinforce that this process does not occur in isolation but spreads through classroom interactions. Students do not merely repeat information but begin to associate trees with the continuity of life. This indicates a shift from surface understanding toward deep contextual understanding.

Furthermore, the presence of documentation in the form of reflective notes demonstrates that this transformation does not stop at the verbal level but has entered into a more stable cognitive structure. The high frequency of findings in the high category indicates that this change is collective rather than individual. Thus, the experience of planting trees serves as an epistemic bridge connecting scientific concepts with the students' lived reality. Oxygen is no longer understood as a subject matter, but as part of the life system they experience firsthand.

Affective Engagement: The Development of a Sense of Care and Ownership

The second finding reveals the affective dimension that develops during the learning process. The tree-planting activity fosters a sense of ownership and care for the environment. Students demonstrated an emotional attachment to the trees they planted.

Table 2. Affective Dimension in Learning

Data Source	Quote / Finding	Frequency	Interpretation
Student 3	"I want the tree to grow quickly so it can produce oxygen."	High	Hope and emotional attachment
Student 4	"If the tree dies, I feel sad."	High	Ecological empathy
Teacher 2	"They have become more attentive to the plants."	Medium	Attitudinal change
Observation	Students water the plants without being asked	High	Spontaneous initiative
Documentation	Photos of students caring for the plants	High	Behavioral consistency

Source: Thematic analysis data by researcher

Table 2 shows that learning does not stop at the cognitive level but extends strongly into the affective dimension. The students' expressions of hope that the trees would grow quickly indicate an emotional attachment that is beginning to form. Oxygen is no longer understood as a concept, but as something "expected to be present" through the trees they care for. Expressions of sadness when a tree dies mark the emergence of ecological empathy—an emotional response that connects human life with the sustainability of nature. In this context, trees are no longer positioned as objects, but as entities that hold value for their lives.

Findings from observation and documentation reinforce that this affection manifests in concrete actions. Students watered the plants without instruction, demonstrating internal initiative rather than mere compliance. Teachers also confirmed a shift in attitude, albeit of moderate intensity. The consistency of behaviour documented in the records confirms that emotional engagement has transformed into a recurring practice. Thus, the affective dimension in this learning process serves as the primary driver, bridging knowledge to action while simultaneously laying the foundation for sustainable ecological behaviour.

Social Awareness: Collective Responsibility for the Environment

The third finding indicates that learning does not stop at the individual level but extends to the social sphere. Students are beginning to demonstrate a collective awareness of the need to protect the environment.

Table 3. Social Dimension and Collectivity

Data Source	Quote / Finding	Frequency	Interpretation
Student 5	"We have to take care of the trees together."	High	Collective awareness
Student 6	"If someone damages it, they should be reminded."	Medium	Social control
Teacher 3	"They have started reminding each other."	High	Social dynamics emerging
Observation	Group discussions while caring for the plants	High	Collaboration
Documentation	Group activities in maintaining the trees	High	Evidence of collectivity

Source: Thematic analysis data by researcher

Table 3 confirms that learning extends beyond the individual sphere and moves toward a broader social construct. Students' statements about taking care of the tree "together" indicate the emergence of a collective consciousness, in which responsibility is no longer a personal matter but a shared commitment. The emergence of a drive to remind one another when someone causes damage signals the formation of social control mechanisms. Findings from the teacher reinforce that this dynamic is not merely theoretical but is already present in students' real-world interactions. Thus, the experience of planting trees has sparked the formation of new social norms oriented toward environmental care.

Observational and documentary data show that this collectivity manifests in collaborative practices. Group discussions during plant care reveal coordination, role division, and lively communication. Joint activities documented in the records affirm the consistency of this collective behaviour. The high frequency of dominant findings indicates that this phenomenon is widespread rather than incidental. Thus, the social dimension in this learning process functions as a reinforcing factor that sustains ecological behaviour, as the values formed are not only internalised individually but also maintained through social interaction.

This study confirms that experience-based oxygen education offers an integrative learning model. It not only connects scientific concepts with practice but also unites cognitive, affective, and social dimensions into a single, holistic learning process. It expands the discourse on environmental education by placing oxygen at the centre of the pedagogical narrative. These findings open up a broader space for reflection on how experience shapes knowledge and values. The following section will discuss these findings within the framework of existing theories and previous research, and examine their implications for the development of environmental education in elementary schools.

Discussion

The findings of this study confirm the existence of a multi-layered transformation in students: from an initially superficial cognitive understanding, through affective engagement, and culminating in the development of social responsibility. This shift does not occur linearly but through concrete experiences that connect the concept of oxygen with the practice of planting trees. Thus, oxygen is no longer present as declarative knowledge but as a reality that is experienced and interpreted. The three dimensions—cognitive, affective, and social—operate simultaneously and reinforce one another, forming a unified and holistic learning process.

Theoretically, these findings can be explained through the experiential learning framework, which positions experience as the foundation of knowledge formation (A. Y. Kolb & Kolb, 2012; D. Kolb, 1984). The cycle of concrete experience, reflection, conceptualisation, and active experimentation is clearly evident in students' processes. However, these findings go beyond this framework by demonstrating that ecological experiences not only generate knowledge but also build emotions and social relationships. From an ecological literacy perspective, this learning connects students to living systems in a more holistic way (Clavin, 2014; Pitman et al., 2018; Sigit et al., 2023). Meanwhile, the concept of biophilia explains why an emotional attachment to trees arises naturally (Barbiero, 2023; Kaplan & Kaplan, 1989; Wilson, 1984). Thus, ecological experience-based learning expands the horizons of learning theory by incorporating affective and social dimensions as integral parts

Compared to previous research, these findings demonstrate both continuity and differentiation. The studies by by Carfora et al. (2017) emphasise the importance of emotional connections with nature, which aligns with findings regarding students' affective engagement. Van der Linden (2019) also confirms that direct experiences contribute to the formation of sustainability values. However, this study makes a further contribution by linking a specific scientific concept—oxygen—to such experiences. de Moura et al. (2018), Calixto-Flores (2020), Sukma et al. (2020), and Stevenson et al. (2020) highlight the importance of environmental education in shaping awareness, but have not explicitly examined how abstract concepts are internalised through concrete practices. Thus, this study bridges the gap between scientific literacy and ecological practices.

The primary novelty of this study lies in the construction of the concept "oxygen-based ecological pedagogy." This concept places oxygen at the centre of the learning narrative, linking it to the experience of planting trees. Epistemologically, this concept consists of four layers: (1) concrete

experience as the basis of knowledge, (2) reflection as a process of internalisation, (3) Emotional: caring for the environment, and (4) social practice as a form of actualisation. This model can be described as follows:

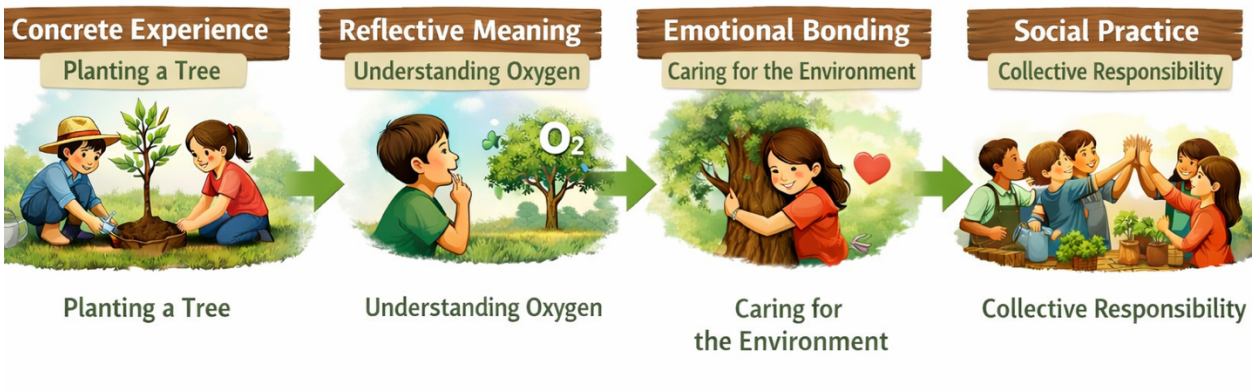

Figure 1. Oxygen-based ecological pedagogy

This model (Figure 1) illustrates that knowledge does not exist in isolation but grows through experience and relationships. The first stage, Concrete Experience (Planting a Tree), marks the starting point of learning grounded in direct experience. Students do not merely receive information; they are physically engaged in planting a tree. The feel of the soil, the planting process, and interaction with the environment present a concrete reality that serves as the foundation of knowledge. In this phase, the concept of oxygen has not yet been explained theoretically, but is being "planted" through sensory experience. This framework aligns with David Kolb's theory of experiential learning, which asserts that effective learning begins with concrete experience as the basis for knowledge construction. Thus, action serves as the epistemological entry point before concepts are formed abstractly.

The second stage, Reflective Meaning (Understanding Oxygen), demonstrates the process of internalising meaning through reflection. Following concrete experiences, students begin to associate the activity of planting trees with its ecological function, specifically as a source of oxygen. The thought process shifts from "what is being done" to "what it means." Oxygen is no longer understood as invisible air, but as the result of the life of the trees they plant. This stage can be explained through constructivist learning theory, pioneered by Jean Piaget, in which knowledge is constructed through processes of assimilation and accommodation based on experience. Reflection becomes a key mechanism in transforming experience into a more stable cognitive structure.

The third stage, Emotional Bonding (Caring for the Environment), demonstrates the emergence of an emotional bond between students and the environment. Trees, which were

previously merely objects, now become part of an affective relationship. A sense of care, a desire to nurture, and even empathy when plants are threatened, emerge naturally. This dimension is reinforced by Edward O. Wilson's biophilia theory, which states that humans have an inherent tendency to connect with living beings and nature. In this context, emotions are not merely a response but become the energy that binds knowledge with action, thereby giving learning a deeper meaning.

The fourth stage, Social Practice (Collective Responsibility), marks the culmination of the learning process as it extends into the social realm. Concern is no longer individual in nature but evolves into collective responsibility. Students begin to collaborate, remind one another, and establish shared norms in caring for the environment. This phenomenon can be explained through Albert Bandura's social learning theory, which emphasises that behaviour is shaped through social interaction, observation, and imitation. Additionally, Émile Durkheim's concept of collective consciousness explains how shared values are formed and maintained within a group. At this stage, learning has transformed into a sustainable social practice, where oxygen is no longer merely a scientific concept but has become a collective value embodied in shared actions.

The theoretical implication of this study is the need to redefine science education in elementary schools. Science should not merely be taught as a collection of concepts, but must be brought to life through meaningful experiences. Practically, this study offers an environment-based learning model that can be integrated into the curriculum. Teachers can utilise simple activities, such as planting trees, to teach complex concepts in context. Socially, this study contributes to developing a generation that is more ecologically aware and environmentally responsible.

However, this study has limitations. The scope, limited to a single school, restricts the generalizability of the findings. Additionally, the relatively short duration of the study has not yet allowed for observation of long-term impacts. Future research needs to examine the sustainability of these learning effects over a longer period and test this model in different contexts. A mixed-methods approach could also be used to measure changes more quantitatively.

Thus, learning about oxygen through the experience of planting trees opens up new perspectives in environmental education. It does not merely teach; it brings things to life. At this point, education rediscovers its most fundamental meaning: shaping individuals who understand, feel, and take responsibility for life.

CONCLUSION

This study underscores one fundamental point: oxygen should not be taught merely as a concept but presented as a lived experience. Through the practice of planting trees, a holistic transformation of meaning occurs within students. Oxygen is no longer understood as an abstract "air," but rather as the result of concrete ecological relationships. Here lies the primary novelty of this study: the construction of "oxygen-based ecological pedagogy" as a learning model that simultaneously integrates cognitive, affective, and social dimensions. The findings indicate that direct experience can shift declarative knowledge into relational understanding, foster emotional attachment to the environment, and shape collective responsibility. Thus, learning produces not only students who know, but also those who care and take action.

The implications of this study are multidimensional. Theoretically, this study extends the experiential learning framework by incorporating an ecological dimension as a space for the actualisation of knowledge. Practically, this study offers a contextual learning model that can be integrated into elementary education, particularly in science instruction and environmental education. Socially, this study contributes to the development of ecological awareness from an early age as a foundation for sustainability. However, this study has limitations due to its narrow scope and relatively short duration, and it has not yet captured long-term impacts. Therefore, future research needs to test this model in a broader context, using longitudinal or mixed-methods approaches, and to explore the integration of other scientific concepts within an experience-based pedagogical framework. Thus, this study not only adds to existing knowledge but also opens new directions in educational practice that are more vibrant and meaningful.

REFERENCES

Adipat, S., & Chotikapanich, R. (2022). Sustainable Development Goal 4: An Education Goal to Achieve Equitable Quality Education. *Academic Journal of Interdisciplinary Studies*, *11*(6), 174–183. https://doi.org/10.36941/ajis-2022-0159

Ardoin, N. M., & Bowers, A. W. (2020). Early childhood environmental education: A systematic review of the research literature. *Educational Research Review*, *31*. https://doi.org/10.1016/j.edurev.2020.100353

Barbiero, G. (2023). Biophilic design reframed. The theoretical basis for experimental research. *Ri-Vista*, *21*(2), 80–91. https://doi.org/10.36253/rv-15678

Bowen, G. A. (2009). Document Analysis as a Qualitative Research Method. *Qualitative Research Journal*, *9*(2), 27–40. https://doi.org/10.3316/QRJ0902027

Braun, V., & Clarke, V. (2006). Using Thematic Analysis in Psychology. *Qualitative Research in Psychology*, *3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Braun, V., & Clarke, V. (2019). Reflecting on Reflexive Thematic Analysis. *Qualitative Research in Sport, Exercise and Health*, *11*(4), 589–597. https://doi.org/10.1080/2159676X.2019.1628806

Calixto-Flores, R. (2020). THE MEANING OF EDUCATIONAL PRACTICES IN ENVIRONMENTAL EDUCATION. *New Trends in Qualitative Research*, *2*, 1–12. https://doi.org/10.36367/ntqr.2.2020.1-12

Carfora, V., Caso, D., Sparks, P., & Conner, M. (2017). Moderating effects of pro-environmental self-identity on pro-environmental intentions and behaviour: A multi-behaviour study. *Journal of Environmental Psychology*, *53*, 92–99. https://doi.org/10.1016/j.jenvp.2017.07.001

Clavin, A. (2014). Ecological Literacy. In *Encyclopedia of Quality of Life and Well-Being Research* (pp. 1779–1783). Springer, Dordrecht. https://doi.org/10.1007/978-94-007-0753-5_811

Cohen, A. J., Brauer, M., Burnett, R., Anderson, H. R., Frostad, J., Estep, K., Balakrishnan, K., Brunekreef, B., Dandona, L., Dandona, R., Feigin, V., Freedman, G., Hubbell, B., Jobling, A., Kan, H., Knibbs, L., Liu, Y., Martin, R., Morawska, L., … Forouzanfar, M. H. (2017). Estimates and 25-year trends of the global burden of disease attributable to ambient air pollution: An analysis of data from the Global Burden of Diseases Study 2015. *The Lancet*, *389*(10082), 1907–1918. https://doi.org/10.1016/S0140-6736(17)30505-6

Creswell, J. W., & Creswell, J. D. (2022). *Research Design*. SAGE Publications, Inc. https://us.sagepub.com/en-us/nam/research-design/book270550

Creswell, J. W., & Poth, C. N. (2017). *Qualitative Inquiry and Research Design: Choosing Among Five Approaches*. SAGE Publications.

de Moura, A. C. de O. S., Cicuto, C. A. T., Monteiro, A. F., Ancini, A. C., Gonçalves, M. C. G., Batista, Z. G., & da Rosa, S. M. (2018). Methodology of trees and concept maps: Paths that integrate and articulate environmental education and science teaching. *Journal of Science Education*, *19*(1), 9–16.

de Vries, K. (2020). Case Study Methodology. In K. Aranda (Ed.), *Critical Qualitative Health Research: Exploring Philosophies, Politics and Practices* (pp. 41–52). Taylor and Francis. https://doi.org/10.4324/9780429432774-2

Fyfe-Johnson, A. L., Hazlehurst, M. F., Perrins, S. P., Bratman, G. N., Thomas, R., Garrett, K. A., Hafferty, K. R., Cullaz, T. M., Marcuse, E. K., & Tandon, P. S. (2021). Nature and children's health: A systematic review. *Pediatrics*, *148*(4). https://doi.org/10.1542/peds.2020-049155

Kaplan, R., & Kaplan, S. (1989). The experience of nature: A psychological perspective. *The Experience of Nature: A Psychological Perspective*.

Knott, E., Rao, A. H., Summers, K., & Teeger, C. (2022). Interviews in The Social Sciences. *Nature Reviews Methods Primers*, *2*(1). https://doi.org/10.1038/s43586-022-00150-6

Kolb, A. Y., & Kolb, D. A. (2012). Experiential Learning Theory. In *Encyclopedia of the Sciences of Learning* (pp. 1215–1219). Springer, Boston, MA. https://doi.org/10.1007/978-1-4419-1428-6_227

Kolb, D. (1984). Experiential Learning: Experience As The Source Of Learning And Development. In *Journal of Business Ethics* (Vol. 1). Prentice-Hall.

Komonkanjanakul, S., & Supapongpichate, R. (2022). A model of participatory learning process for management of environmental health impacts in industrial communities area. *Journal of Health Research*, *36*(6), 986–996. https://doi.org/10.1108/JHR-07-2020-0277

Lelieveld, J., Evans, J. S., Fnais, M., Giannadaki, D., & Pozzer, A. (2015). The contribution of outdoor air pollution sources to premature mortality on a global scale. *Nature*, *525*(7569), 367–371. https://doi.org/10.1038/nature15371

Masson-Delmotte, V., Zhai, P., Pirani, A., Connors, S. L., Péan, C., Berger, S., Caud, N., Chen, Y., Goldfarb, L., Gomis, M. I., Huang, M., Leitzell, K., Lonnoy, E., Matthews, J. B. R., Maycock, T. K., Waterfield, T., Yelekçi, Ö., Yu, R., & Zhou, B. (Eds.). (2021). *Climate Change 2021: The Physical*

Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press. https://doi.org/10.1017/9781009157896

Pitman, S. D., Daniels, C. B., & Sutton, P. C. (2018). Characteristics associated with high and low levels of ecological literacy in a western society. *International Journal of Sustainable Development and World Ecology*, *25*(3), 227–237. https://doi.org/10.1080/13504509.2017.1384412

Ponticell, J. A., Zepeda, S. J., Lanoue, P. D., Haines, J. G., Jimenez, A. M., & Ata, A. (2018). Observation, feedback, and reflection. In S. J. Zepeda & J. A. Ponticell (Eds.), *The Wiley Handbook of Supervision* (pp. 251–279). wiley. https://doi.org/10.1002/9781119128304.ch11

Schneller, A. J., Lacy, G., Kellogg, S., Pettigrew, S. M., Denny, C., Feldman-Schwartz, G., Beard, I., Rhodes, A., Wilson Radcliffe, B., Erickson, A., & Bardin, I. (2022). Urban ecojustice education: Transformative learning outcomes with high school service learners. *Journal of Environmental Education*, *53*(3), 127–140. https://doi.org/10.1080/00958964.2022.2063784

Sharma-Brymer, V., Brymer, E., Gray, T., & Davids, K. (2018). Affordances guiding Forest School practice: The application of the ecological dynamics approach. *Journal of Outdoor and Environmental Education*, *21*(1), 103–115. https://doi.org/10.1007/s42322-017-0004-3

Shulla, K., Filho, W. L., Lardjane, S., Sommer, J. H., & Borgemeister, C. (2020). Sustainable development education in the context of the 2030 Agenda for sustainable development. *International Journal of Sustainable Development and World Ecology*, *27*(5), 458–468. https://doi.org/10.1080/13504509.2020.1721378

Sigit, D. V., Ristanto, R. H., Nurrismawati, A., Komala, R., Prastowo, P., & Katili, A. S. (2023). Ecoliteracy's contribution to creative thinking: A study of senior high school students. *Journal of Turkish Science Education*, *20*(2), 356–368. https://doi.org/10.36681/tused.2023.020

Stevenson, P. C., Bidartondo, M. I., Blackhall-Miles, R., Cavagnaro, T. R., Cooper, A., Geslin, B., Koch, H., Lee, M. A., Moat, J., O'Hanlon, R., Sjöman, H., Sofo, A., Stara, K., & Suz, L. M. (2020). The state of the world's urban ecosystems: What can we learn from trees, fungi, and bees? *PLANTS, PEOPLE, PLANET*, *2*(5), 482–498. https://doi.org/10.1002/ppp3.10143

Sukma, E., Ramadhan, S., & Indriyani, V. (2020). Integration of environmental education in elementary schools. *J. Phys. Conf. Ser.*, *1481*(1). https://doi.org/10.1088/1742-6596/1481/1/012136

Talebpour, L. M., Busk, P. L., Heimlich, J. E., & Ardoin, N. M. (2020). Children's connection to nature as fostered through residential environmental education programs: Key variables explored through surveys and field journals. *Environmental Education Research*, *26*(1), 95–114. https://doi.org/10.1080/13504622.2019.1707778

van der Linden, S. (2019). Editorial. *Journal of Environmental Psychology*, *61*, A1–A4. https://doi.org/10.1016/j.jenvp.2019.01.005

Wilson, E. O. (1984). *Biophilia*. Harvard University Press. https://books.google.co.id/books/about/BIOPHILIA.html?id=CrDqGKwMFAkC&redir_esc=y

Yin, R. K. (2014). *Case Study Research*. SAGE Publications. https://books.google.co.id/books?id=Cdk5DQAAQBAJ