INTERNATIONAL JOURNAL OF SOCIAL SCIENCE, EDUCATIONAL, ECONOMICS, AGRICULTURE RESEARCH AND TECHNOLOGY (IJSET) | ISSN (E): 2827-766X
Website: https://ijset.org/ | Volumes 5 No. 8 (2026)

GREEN LEARNING SPACE AS AN AUTHENTIC LEARNING ENVIRONMENT TO IMPROVE ELEMENTARY STUDENTS' SCIENCE ACHIEVEMENT

Jaka Waluya[1]*, Epon Ningrum[2], Iwan Setiawan[3], Amin[4]
[1,2,3,4] Universitas Pendidikan Indonesia, Bandung, Indonesia
E-mail: jacko.waluya@upi.edu [1]*, eponningrum@upi.edu[2], iwansetiawan@upi.edu[3], aminunisma@gmail.com[4]

Received: 01/06/2026 | **Revised** : 05/06/2026 | **Accepted:** 20/06/2026 | **Published** :03/07/2026

Abstract

IPAS instruction in elementary schools is still dominated by the lecture method, resulting in students having limited opportunities for hands-on learning experiences. This study aims to analyze the effect of implementing a Green Learning Space through the use of an open green garden on students' learning outcomes and learning activities in the IPAS subject. The study employed a quantitative approach using a pre-experimental method with a One-Group Pretest–Posttest Design. The study was conducted with 24 third-grade students at SDIT Nurul Iman Pondok Bambu, East Jakarta, who were selected using total sampling. Data were collected through achievement tests, observations of learning activities, and student response questionnaires. The data were analyzed descriptively using mean scores, the percentage of learning mastery, the percentage of learning activities, and Normalized Gain (N-Gain). The results showed that the average learning achievement increased from 64.13 on the pretest to 81.33 on the posttest, with the percentage of learning mastery rising from 8.33% to 87.50%. The N-Gain value of 0.48 falls into the moderate category. Additionally, student learning activity reached an average of 82.64%, indicating an active category during the learning process. Thus, the implementation of the Green Learning Space effectively improves student learning outcomes and learning activity while providing a more contextual, meaningful, and student-centered learning experience.

Keywords: *Green Learning Space; green open space; learning outcomes; learning activities; IPAS.*

INTRODUCTION

The teaching of Natural and Social Sciences (IPAS) in elementary school plays a strategic role in developing students' ability to understand natural phenomena, the social environment, and the reciprocal relationship between humans and their environment (Gal, 2025; Gómez-Oliván et al., 2025). In line with the implementation of the Merdeka Curriculum, IPAS learning is no longer oriented solely toward conceptual mastery but is also aimed at developing critical thinking, problem-solving, creativity, collaboration, and environmental awareness through contextual and meaningful learning experiences (Siringo Ringo, 2025). Therefore, the learning process needs to provide students with opportunities to construct knowledge through direct experiences related to daily life.

However, the implementation of IPAS learning in various elementary schools is still dominated by a teacher-centered approach. The learning process generally takes place in the classroom through lectures, the use of textbooks, and student worksheets, so students' interaction with real objects in their surroundings remains relatively limited. These conditions make learning less engaging, reduce students' motivation, and make it difficult for them to understand the abstract concepts of IPAS. In fact, the nature of IPAS learning requires students to observe, explore, investigate, and connect scientific concepts with the phenomena they encounter in their daily lives (Cheng & So, 2015). One alternative for addressing this issue is outdoor learning (Petkou et al., 2021). This approach utilizes the environment as a learning resource so that students can interact directly with real objects, gain authentic learning experiences, and connect IPAS concepts to their surroundings (Craig & Allen, 2015). Thus, learning is not only oriented toward the transfer of knowledge but also toward the creation of more meaningful and contextual learning experiences. The effectiveness of environment-based learning has been widely demonstrated through various studies. Rodríguez Pérez et al., (2024) reported that utilizing school gardens as a learning resource can improve student learning outcomes through observation of real-world objects. These findings are supported by Gunansyah et al., (2021) who showed that learning outside the classroom yields better learning outcomes than conventional learning.

Furthermore, Craig & Allen, (2015) emphasize that environment-based learning not only improves learning outcomes but also fosters students' motivation, engagement, critical thinking skills, and conceptual understanding. Overall, these studies indicate that the school environment is an effective learning resource for supporting science education.

Nevertheless, previous studies have primarily focused on the use of the environment as a learning method or strategy (Gómez-Oliván et al., 2025; Kroufek et al., 2018; Schmidt & Häggström, 2022). Existing studies have mostly evaluated the effectiveness of outdoor learning activities on learning outcomes, while the use of green open spaces as systematically designed learning environments has not received much attention. In other words, green open spaces have not yet been positioned as a learning ecosystem that integrates observation, exploration, collaboration, reflection, and scientific inquiry in a sustainable manner. This situation indicates that there remains a research gap regarding the development of Green Learning Spaces as authentic learning environments for IPAS instruction in elementary schools.

In this study, the Green Learning Space is understood as the utilization of green open spaces that are systematically designed as an authentic learning environment, rather than simply moving learning activities outside the classroom. Through the Green Learning Space, students interact directly with various environmental components, such as plants, soil, air, sunlight, and other living things, thereby gaining concrete learning experiences through activities such as observing, asking questions, gathering information, discussing, and drawing conclusions (Shume, 2016). This approach aligns with constructivist theory, which emphasizes that knowledge is constructed through active interaction between students and their environment, as well as experiential learning theory, which views direct experience as the foundation for meaningful understanding (Nieto-Ramos et al., 2025).

The Nurul Iman Integrated Islamic Elementary School in Pondok Bambu, East Jakarta, has green open spaces that have the potential to be used as nature-based learning laboratories; however, their use in IPAS instruction has not yet been optimized. So far, learning has mostly taken place inside the classroom, so students' opportunities to gain hands-on learning experiences through their surrounding environment remain limited. In fact, the green open space on the school grounds provides various real-world objects relevant to IPAS curriculum content and has the potential to serve as a contextual learning resource.

Based on the above discussion, this study aims to analyze the implementation of the Green Learning Space through the use of open green spaces as authentic learning environments in IPAS instruction in elementary schools. The novelty of this study lies in the development of the Green Learning Space concept as a learning environment systematically designed to integrate hands-on learning experiences, observation, exploration, collaboration, and reflection into IPAS instruction. Thus, this study is expected not only to provide empirical evidence regarding improvements in student learning outcomes but also to enrich the development of environment-based learning as an alternative approach to contextual learning in elementary schools.

LITERATURE REVIEW

Environment-Based IPAS Learning

IPAS instruction in elementary school emphasizes the connection between scientific concepts and the phenomena that students encounter in their daily lives (Setiadi et al., 2023). Therefore, the learning process is not only focused on presenting material but also on providing learning experiences that allow students to observe, explore, and analyze their environment firsthand. Environment-based learning is one approach that can connect IPAS concepts to real-world contexts, thereby providing students with a more meaningful learning experience (Demir Yıldız, 2025).

The school environment, particularly green open spaces, has the potential to serve as a learning resource that provides real-world objects to support IPAS learning (Handayani & Solihatin, 2024; Svobodová & Kroufek, 2022). Through activities such as observing plants, soil, air, sunlight, and other living organisms, students can develop a more concrete conceptual understanding than they would through teacher explanations in the classroom alone. Environment-based learning also encourages students to develop critical thinking and problem-solving skills, collaborate, and foster a sense of environmental stewardship (Noviana et al., 2019).

The Concept of a Green Learning Space

The Green Learning Space is a learning concept that utilizes green open spaces as a learning environment systematically designed to support the learning process (Herrington et al., 2003). This concept does not merely move learning activities outside the classroom, but rather makes the environment an integral part of the learning process through observation, exploration, discussion, reflection, and scientific inquiry (Wang et al., 2026). In a Green

Learning Space, students interact directly with various environmental components, making the learning experience more authentic. The environment serves not only as a learning medium but also as a natural laboratory that allows students to construct knowledge based on real-world experiences (Erdogan, 2015). Thus, the Green Learning Space supports contextual, participatory, and student-centered learning. The implementation of Green Learning Spaces also provides teachers with the opportunity to develop more varied learning activities by utilizing the potential of the school environment (Syofyan & Rachmadtullah, 2019). addition to improving learning outcomes, this approach has the potential to foster environmental awareness, observational skills, communication skills, and collaboration among students (Uhrinová et al., 2021).

Theoretical Framework

This study is based on constructivist theory, which states that knowledge is actively constructed by learners through their interactions with their environment and the learning experiences they gain (Lovren & Jablanovic, 2023). From a constructivist perspective, learning is more meaningful when students are directly involved in the process of discovering concepts rather than simply receiving information from the teacher (Suhartini & Haerani, 2024). In addition, this study also draws on the Experiential Learning theory proposed by Istiq Faroh & Yasin, (2025) This theory explains that the learning process occurs through four stages: concrete experience, reflective observation, abstract conceptualization, and active experimentation. The implementation of the Green Learning Space facilitates these four stages because students gain direct experience through observing the environment, discussing their observations, relating them to IPAS concepts, and then applying the knowledge they have gained to understand the phenomena around them (Vioreza et al., 2023). Based on this theoretical review, the Green Learning Space is viewed as a learning approach capable of integrating direct learning experiences with the process of knowledge construction, thereby having the potential to improve students' learning outcomes in IPAS.

METHOD

Research Design

This study employed a quantitative approach using a pre-experimental design, specifically a One-Group Pretest–Posttest Design. This design was chosen to determine changes in students' learning outcomes following the implementation of Green Learning Space-based instruction. In this design, students took a pretest before receiving the intervention, then participated in learning activities utilizing an open green space as a learning environment, and finally took a posttest. The difference between the pretest and posttest scores was used as the basis for determining the improvement in students' learning outcomes following the implementation of the Green Learning Space.

Population and Sample

The study was conducted at SDIT Nurul Iman Pondok Bambu, East Jakarta, during the odd semester of the 2025/2026 academic year. The study population consisted of all 24 third-grade students. Given the relatively small population size, total sampling was used, meaning the entire population served as the study sample. The research sample consisted of 24 students who participated in the entire learning series using the Green Learning Space.

Data Collection Methods

Research data were collected using tests, observations, and questionnaires. Tests were used to measure students' learning outcomes through pretests administered before instruction and posttests administered after Green Learning Space-based instruction. The test instruments were designed in accordance with the IPAS material being studied. Observations were conducted during the learning process to assess students' learning activities. The aspects observed included attention to the teacher's explanations, the ability to observe objects in the green open space, recording observation results, participating in group discussions, asking or answering questions, and summarizing learning outcomes. Questionnaires were administered to students after the learning activities were completed to gauge their responses to the implementation of the Green Learning Space as a learning environment.

Data Analysis Techniques

The research data were analyzed descriptively to determine students' learning outcomes and learning activities after participating in Green Learning Space-based instruction. Learning outcomes were analyzed based on pretest and posttest scores by calculating the mean, maximum score, minimum score, percentage of learning mastery, and improvement in learning outcomes using Normalized Gain (N-Gain). The N-Gain criteria follow Hake's classification: high (≥ 0.70), moderate (0.30–0.69), and low (< 0.30). Students' learning activities were analyzed

based on observations during the learning process by calculating the percentage of achievement for each activity indicator. Subsequently, the percentage for each indicator was calculated to determine the average level of students' learning activities during the Green Learning Space-based instruction. Student response data were analyzed descriptively using percentages to determine the level of student acceptance of Green Learning Space-based instruction.

RESULTS

Student Learning Outcomes

The implementation of the Green Learning Space through the use of open green spaces showed an improvement in the IPAS learning outcomes of third-grade students at SDIT Nurul Iman Pondok Bambu, East Jakarta. This improvement was identified by comparing the pretest and posttest scores administered before and after the learning activities. The scores for each student are presented in Table 1.

Table 1. Students' Pretest and Posttest Scores

No.	Student ID	Pretest Score	Posttest Score	Improvement
1	S1	55	76	21
2	S2	60	80	20
3	S3	65	84	19
4	S4	70	86	16
5	S5	58	78	20
6	S6	62	79	17
7	S7	75	88	13
8	S8	68	82	14
9	S9	50	72	22
10	S10	64	81	17
11	S11	72	87	15
12	S12	59	76	17
13	S13	66	84	18
14	S14	61	80	19
15	S15	78	90	12
16	S16	63	82	19
17	S17	57	74	17
18	S18	69	85	16
19	S19	60	79	19
20	S20	73	88	15
21	S21	54	70	16
22	S22	67	84	17
23	S23	62	81	19
24	S24	71	86	15

Based on Table 1, all students showed an improvement in their scores after participating in Green Learning Space-based instruction. The improvement in scores ranged from 12 to 22 points. No students experienced a decline in their scores on the posttest, indicating that instruction utilizing the natural environment has a positive impact on improving IPAS learning outcomes. A summary of the students' learning outcomes is presented in Table 2.

Table 2. Summary of Student Learning Outcomes

Components	Pretest	Posttest
Number of students	24	24
Highest score	78	90
Lowest score	50	70
Average score	64,13	81,33
Students who met the standard	2 Students	21 Students
Number of students who did not meet the standard	22 Students	3 Students
Percentage of students who met the standard	8,33%	87,50%

Based on Table 2, the students' average score increased from 64.13 on the pretest to 81.33 on the posttest, representing an increase of 17.20 points. The percentage of students who achieved mastery also increased

significantly from 8.33% (2 students) to 87.50% (21 students). Conversely, the number of students who did not achieve mastery decreased from 22 to 3. These results indicate an improvement in learning outcomes following the implementation of the Green Learning Space. The distribution of learning outcome categories before and after the intervention is presented in Table 3.

Table 3. Categories of Student Learning Outcomes

Grade Categories	Value Range	Pretest	Percentage	Posttest	Percentage
Excellent	85–100	0 student	0%	7 student	29,17%
Good	75–84	2 student	8,33%	14 student	58,33%
Fair	65–74	9 student	37,50%	3 student	12,50%
Poor	< 65	13 student	54,17%	0 student	0%
Total		24 student	100%	24 student	100%

Based on Table 3, prior to the instruction, most students fell into the “below average” (54.17%) and “average” (37.50%) categories. After the instruction, no students remained in the “below average” category. Most students moved into the “good” (58.33%) and “very good” (29.17%) categories. This shift in distribution indicates an improvement in learning outcomes after students participated in environment-based learning. The magnitude of the improvement in learning outcomes was analyzed using N-Gain values, as presented in Table 4.

Table 4. Improvement in Student Learning Outcomes

Aspect	Value
Pre-test mean	64,13
Post-test mean	81,33
Difference in improvement	17,20
Percentage improvement	26,84%
N-Gain	0,48
N-Gain category	Currently

The results of the analysis show that the N-Gain value of 0.48 falls into the moderate category. This indicates that the implementation of the Green Learning Space is quite effective in improving learning outcomes by helping students understand IPAS material through hands-on learning experiences.

Student Learning Activities

Students’ learning activities during lessons using the Green Learning Space were observed using an observation sheet, as shown in Table 5.

Table 5. Results of Observations of Students’ Learning Activities

No.	Aspects Observed	Number of Active Students	Percentage
1	Full concentration on the teacher’s explanation	19 student	79,17%
2	Observing objects in the open green space	22 student	91,67%
3	Recording observation results	20 student	83,33%
4	Discussing with group members	21 student	87,50%
5	Asking or answering questions	18 student	75,00%
6	Summarizing learning outcomes	19 student	79,17%
	Average		82,64%

Based on Table 5, student learning activities fell into the “active” category, with an average percentage of 82.64%. The highest level of activity was observed in the activity of observing objects in the open green space, at 91.67%, followed by group discussions at 87.50% and recording observation results at 83.33%. The activity of asking or answering questions accounted for 75.00%, while the activities of paying attention to the teacher’s explanations and drawing conclusions from the learning outcomes each reached 79.17%. These findings indicate that Green Learning Space-based learning is effective in encouraging students’ active engagement throughout the learning process.

DISCUSSION

The research results show that the implementation of the Green Learning Space is effective in improving elementary school students' IPAS learning outcomes. This improvement is evident in the increase in students' average scores from 64.13 on the pretest to 81.33 on the posttest, accompanied by an increase in the learning achievement rate from 8.33% to 87.50%. Furthermore, the N-Gain score of 0.48 falls into the moderate category, indicating that Green Learning Space-based instruction is quite effective in improving learning outcomes. This improvement in learning outcomes occurred because instruction was delivered through hands-on learning experiences in a natural environment. Students not only received information from teachers but also directly observed various objects related to IPAS material, such as plants, soil, air, sunlight, and living organisms in the surrounding open green spaces. These hands-on learning experiences helped students connect the concepts they were learning to their surrounding environment, making the material easier to understand (Fernández et al., 2022). Learning that provides hands-on experiences also encourages students to develop their own understanding through the process of observing, discussing, and drawing conclusions from their observations (Baek et al., 2025).

In addition to improving learning outcomes, the implementation of the Green Learning Space also increased students' learning activities (Omidi et al., 2025). Observation results showed that the average level of learning activity reached 82.64%, falling into the "active" category. High student activity was particularly evident in activities such as directly observing objects, discussing, and recording observation results. These conditions indicate that outdoor learning can increase student engagement in the learning process. High learning activity is one of the factors supporting improved learning outcomes because students have the opportunity to interact directly with learning objects and collaborate in groups.

The findings of this study are consistent with the research Balážová et al., (2024) which states that using school gardens as a learning resource can improve elementary school students' IPAS learning outcomes. Similar results were also reported by Shakirova et al., (2024), which shows that environment-based learning yields better learning outcomes than conventional classroom-based learning. In addition, Ward et al., (2023) also found that context-based, environment-centered learning can enhance students' conceptual understanding through authentic learning experiences. The consistency of these findings indicates that the natural environment is an effective learning resource for supporting IPAS instruction in elementary schools.

Nevertheless, this study has distinct characteristics compared to previous research. Most prior studies utilized the environment as a medium or method for out-of-classroom learning. This study develops the concept of the Green Learning Space, which involves the use of open green spaces as learning environments systematically designed to support IPAS learning (Ninsiana, 2024). With this approach, open green spaces are not only used as temporary learning venues but also as learning environments that provide contextual experiences and encourage students to interact directly with the objects they are studying (Fisher-Maltese et al., 2018).

The findings of this study suggest that schools do not need to have fully equipped laboratories to improve the quality of IPAS instruction. The green open spaces available on school grounds can be optimized as natural laboratories that support observation, discussion, exploration, and experiential learning. Therefore, teachers can harness the potential of the school environment as part of their instructional strategies to create a learning process that is more contextual, engaging, and meaningful. This study has several limitations, including the fact that it involved only one school with a relatively small sample size, so the results cannot yet be widely generalized. In addition, the study used a pre-experimental design without a control group, so the improvement in learning outcomes cannot yet be fully compared with other learning models. Future research is recommended to use an experimental design involving a larger sample and to examine the impact of Green Learning Spaces on other aspects, such as critical thinking skills, science literacy, and environmental awareness.

CONCLUSION

This study shows that the implementation of Green Learning Spaces through the use of open green spaces as learning environments can improve elementary school students' IPAS learning outcomes. This improvement is evidenced by an increase in the average score from 64.13 on the pretest to 81.33 on the posttest, an increase in the mastery rate from 8.33% to 87.50%, and an N-Gain score of 0.48, which falls into the moderate category. Furthermore, students' learning activities fell into the "active" category with an average percentage of 82.64%, indicating that environment-based learning can foster more optimal student engagement during the learning process. These findings confirm that the Green Learning Space is an effective learning alternative for creating contextual, meaningful, and student-centered learning experiences. The use of open green spaces not only supports improved learning outcomes but also encourages students to interact directly with the environment as a learning resource.

However, this study is still limited to a single school with a relatively small sample size and employs a pre-experimental design without a control group. Therefore, future research is recommended to involve a broader sample, use a stronger experimental design, and examine the impact of Green Learning Spaces on other aspects, such as thinking skills, science literacy, problem-solving abilities, and environmental awareness.

REFERENCES

Baek, C., Saito-Stehberger, D., Nam, A., Lopez, G., Jacob, S., & Warschauer, M. (2025). Empowering Latine elementary school students with disabilities: computer programming through culturally sustaining curriculum. *Computer Science Education*, *35*(4), 669–694. https://doi.org/10.1080/08993408.2024.2396749

Balážová, M., Ciceková, J., Macko, J., & Záhorská, E. (2024). Ecological Literacy of Pupils of Primary Education in Slovakia as a Precondition of Biodiversity Education. *European Journal of Educational Research*, *13*(4), 1791–1803. https://doi.org/10.12973/eu-jer.13.4.1791

Cheng, I. N. Y., & So, W. W. M. (2015). Teachers' environmental literacy and teaching - Stories of three Hong Kong primary school teachers. *International Research in Geographical and Environmental Education*, *24*(1), 58–79. https://doi.org/10.1080/10382046.2014.967111

Craig, C. A., & Allen, M. W. (2015). The impact of curriculum-based learning on environmental literacy and energy consumption with implications for policy. *Utilities Policy*, *35*, 41–49. https://doi.org/10.1016/j.jup.2015.06.011

Demir Yıldız, C. (2025). Raising Climate Heroes: Ecological Game Camp—A Mixed-Methods Study on Experiential Climate Education in Children and Adults. *Sustainability (Switzerland)*, *17*(17). https://doi.org/10.3390/su17178043

Erdogan, M. (2015). The effect of summer environmental education program (SEEP) on elementary school students' environmental literacy. *International Journal of Environmental and Science Education*, *10*(2), 165–181. https://doi.org/10.12973/ijese.2015.238a

Fernández, A. G., Marín, F. R., Ramírez, E. S., & Díaz, J. E. G. (2022). Validation of a questionnaire about Environmental Literacy through expert judgement. *Revista Eureka*, *19*(3), 310101–310121. https://doi.org/10.25267/Rev_Eureka_ensen_divulg_cienc.2022.v19.i3.3101

Fisher-Maltese, C., Fisher, D. R., & Ray, R. (2018). Can learning in informal settings mitigate disadvantage and promote urban sustainability? School gardens in Washington, DC. *International Review of Education*, *64*(3), 295–312. https://doi.org/10.1007/s11159-017-9663-0

Gal, A. (2025). A hackathon as a promoter of environmental citizenship among fifth-grade students—the attitudes of students, educators, ornithologists, and people working in high-tech. *Education, Citizenship and Social Justice*, *20*(2), 319–341. https://doi.org/10.1177/17461979241253556

Gómez-Oliván, L. M., Téllez-López, A. M., Orozco-Hernández, J. M., Juan-Reyes, N. S., Rosales-Pérez, K. E., Elizalde-Velázquez, G. A., Herrera-Vázquez, S. E., & Tapia-Bárcenas, I. A. (2025). Design and validation of an environmental literacy tool for Mexican schoolchildren: guiding curriculum-based interventions on water conservation, recycling, solid waste management, and medication disposal. *Environmental Science and Pollution Research*, *32*(47), 27299–27310. https://doi.org/10.1007/s11356-025-37231-4

Gunansyah, G., Zuhdi, U., & Info, A. (2021). *Sustainable development education practices in elementary schools*. *15*(2), 178–187. https://doi.org/10.11591/edulearn.v15i2.17091

Handayani, T., & Solihatin, E. (2024). The effectiveness of project based blended learning ecoliteracy E-module to improve environmental care character. In K. D., P. R.M., A. R., & A. R. (Eds.), *AIP Conference Proceedings* (Vol. 3148, Issue 1). American Institute of Physics. https://doi.org/10.1063/5.0242374

Herrington, J., Oliver, R., & Reeves, T. C. (2003). *Patterns of engagement in authentic online learning environments*. *19*(1), 59–71.

Istiq Faroh, N., & Yasin, F. N. (2025). Effectiveness of local culture supplement books in improving students' ecoliteracy in coastal areas. *Perspektivy Nauki i Obrazovania*, *73*(1), 202–216. https://doi.org/10.32744/pse.2025.1.13

Kroufek, R., Chytrý, V., & Uhrinová, M. (2018). The effect of the type of the finished high school on the nature relatedness of pre-service primary teachers. *New Educational Review*, *54*(4), 231–243. https://doi.org/10.15804/tner.2018.54.4.19

Lovren, V. O., & Jablanovic, M. M. (2023). Bridging the Gap: The Affective Dimension of Learning Outcomes in Environmental Primary and Secondary Education. *Sustainability (Switzerland)*, *15*(8). https://doi.org/10.3390/su15086370

Nieto-Ramos, M., Puig-Gutiérrez, M., Rodríguez-Marín, F., & Dos Santos Miranda-Pinto, M. (2025). Learning

Progressions on Pro-Environmental Behaviors for Building Resilient Citizenship through Instagram. *Edutec*, *2025*(94), 371–390. https://doi.org/10.21556/edutec.2025.94.4295

Ninsiana, W. (2024). Introducing eco-literacy to early childhood students through digital learning. *Journal of Education and Learning*, *18*(1), 89–96. https://doi.org/10.11591/edulearn.v18i1.20678

Noviana, E., Kurniaman, O., Salwa, N., Hermita, N., Afendi, N., Zufriady, Z., & Misliati, M. (2019). Ecological Knowledge of Elementary School Students Through the Use of Ecoliteracy Teaching Materials in Curriculum 2013. In S. null, D. of P. Universitas Riau Jl. HR. Soebrantas, Pekanbaru, N. T.T., D. of C. Universitas Riau Jl. HR. Soebrantas, Pekanbaru, T. S., G. D. University of Malaya Jalan Universiti, Kuala Lumpur, E. null, J. H. R. S. Universitas Riau Pekanbaru, L. R., J. H. R. S. Universitas Riau Pekanbaru, F. null, B. D. Universitas Riau Jl. HR. Soebrantas, Pekanbaru, H. N., F. Universitas Riau Jl. HR. Soebrantas, Pekanbaru, N. null, F. Universitas Riau Jl. HR. Soebrantas, Pekanbaru, D. null, & F. Universitas Riau Jl. HR. Soebrantas, Pekanbaru (Eds.), *Journal of Physics: Conference Series* (Vol. 1351, Issue 1). Institute of Physics Publishing. https://doi.org/10.1088/1742-6596/1351/1/012071

Omidi, M., Jafarkhani, F., & Shirkarami, A. (2025). Impact of Ashiyan Board Game on Iranian Students' Understanding of Native Vertebrates. In S. H.D.I. & M. R.I. (Eds.), *Proceedings of the European Conference on Games-based Learning* (Vol. 19, Issue 2, pp. 1020–1026). Dechema e.V. https://doi.org/10.34190/ecgbl.19.2.4037

Petkou, D., Andrea, V., & Anthrakopoulou, K. (2021). The impact of training environmental educators: Environmental perceptions and attitudes of pre-primary and primary school teachers in Greece. *Education Sciences*, *11*(6). https://doi.org/10.3390/educsci11060274

Rodríguez Pérez, L., Azcárate Goded, M. D. P., & García-González, E. (2024). Environmental Literacy in Initial Teacher Training: Pre-Service Teachers' Perceptions of the Socio-Environmental Impact of Food. *Education Sciences*, *14*(8). https://doi.org/10.3390/educsci14080912

Schmidt, C., & Häggström, M. (2022). Sensing, Naming, and Narrating About the Lived World: Places as Textual Resources. In *Sustainable Development Goals Series: Vol. Part F2697* (pp. 81–92). Springer. https://doi.org/10.1007/978-3-030-84510-0_6

Setiadi, H. W., Dwiningrum, S. I. A., & Mustadi, A. (2023). Portrait of Ecoliteracy Competence in Elementary School Students: Relationship of Ecoliteracy Competence on Environmental Sustainability in Indonesia. *Environment and Ecology Research*, *11*(6), 993–1001. https://doi.org/10.13189/eer.2023.110610

Shakirova, N., Berechikidze, I., & Gafiyatullina, E. (2024). The effects of immersive AR technology on the environmental literacy, intrinsic motivation, and cognitive load of high school students. *Education and Information Technologies*, *29*(8), 9121–9138. https://doi.org/10.1007/s10639-023-12144-2

Shume, T. (2016). Teachers' perspectives on contributions of a prairie restoration project to elementary students' environmental literacy. *International Journal of Environmental and Science Education*, *11*(12), 5331–5348. https://www.scopus.com/pages/publications/84982239361?origin=resultslist

Siringo Ringo, S. (2025). Systematic Literature Review dengan Metode Prisma: Pembelajaran Berdiferensiasi pada Pendidikan Dasar. In *Jurnal Didaktika Pendidikan Dasar* (Vol. 9, Issue 1, pp. 209–226). SCAD Independent. https://doi.org/10.26811/didaktika.v9i1.1760

Suhartini, E., & Haerani, R. P. R. (2024). Environmental literacy profile of primary teacher candidates in tropical rainforests environment context. In R. E., W. A., W. P., T. N.K., H. S., F. F., & D. W.S.B. (Eds.), *AIP Conference Proceedings* (Vol. 2622, Issue 1). American Institute of Physics. https://doi.org/10.1063/5.0134012

Svobodová, S., & Kroufek, R. (2022). Environmental Literacy of ISCED 2 Pupils in the Czech Republic and Slovakia. *European Journal of Science and Mathematics Education*, *10*(4), 519–528. https://doi.org/10.30935/scimath/12361

Syofyan, H., & Rachmadtullah, R. (2019). Increasing ecoliteracy on the impact of organic waste management using a problem a problem-solving the model. *International Journal of Scientific and Technology Research*, *8*(9), 1981–1983. https://www.scopus.com/pages/publications/85073437066?origin=resultslist

Uhrinová, M., Balážová, M., Kroufek, R., & Synaková, E. (2021). Selected Aspects of Environmental Literacy Among Pupilswith Regard to the Aims of Primary Education. *New Educational Review*, *66*, 57–70. https://doi.org/10.15804/tner.2021.66.4.05

Vioreza, N., Supriatna, N., & Hakam, K. A. (2023). The effect of utilizing Betawi local food in the implementation of Pancasila student profile strengthening project on increasing ecoliteracy of elementary school students. *Kasetsart Journal of Social Sciences*, *44*(4), 1115–1126. https://doi.org/10.34044/j.kjss.2023.44.4.16

Wang, G., Zhang, Y., & Wang, W. (2026). Evaluating the performance of informal learning spaces in higher

Education : an integrated methodological framework combining Space Syntax and Post-Occupancy Evaluation. *Journal of Asian Architecture and Building Engineering*, *00*(00), 1–20. https://doi.org/10.1080/13467581.2026.2664276

Ward, N. M., Garrard, G., Gregg, E. A., May, B., Wandin, D., Harrison, M., Pascoe, M., McConachie, F., Moggridge, B., Kusmanoff, A., & Bekessy, S. A. (2023). "Totemic species" can be an effective lens for engaging students with Indigenous knowledge and biodiversity conservation. *Conservation Science and Practice*, *5*(4). https://doi.org/10.1111/csp2.12904