Teachers' Awareness and Utilization of Outdoor Resources in Junior High School Science: Basis for a Supplementary Catalogue

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ABSTRACT

Science education in the Philippines faces persistent challenges, including low performance in national and international assessments, which highlight the need for innovative teaching strategies. Outdoor resources have been identified as effective tools for fostering experiential learning and enhancing student engagement, yet their potential remains underexplored in many educational settings. This study addresses this gap by examining junior high school science teachers' awareness and utilization of outdoor resources in three private schools in Bayombong, Nueva Vizcaya, during the 2022–2023 academic year. Employing a quantitative-qualitative descriptive design, it evaluates teachers' level of awareness, extent of utilization, and best practices for integrating outdoor resources into science education. Results indicate a moderate level of awareness and utilization, with school gardens being the most frequently used resource, while parks, museums, and other alternatives are underutilized due to logistical constraints. Findings highlight the potential of outdoor resources to improve science education through hands-on activities, environmental stewardship, and inquiry-based learning. The study concludes with the development of a supplementary catalogue designed to aid teachers in implementing curriculum-aligned, outdoor science activities that foster experiential learning and interdisciplinary connections.

Keywords: curriculum integration, environmental awareness, experiential learning, junior high school teaching, outdoor resources, research gap, science education

INTRODUCTION

Education is a crucial tool for personal growth and national development, equipping individuals with knowledge, skills, and adaptability to overcome challenges. In the Philippines, education reform has been a priority, leading to the introduction of the K to 12 curriculum, which extends basic education to 12 years to align with global standards and enhance graduates' competitiveness. However, despite these efforts, challenges persist, particularly in science education, where Filipino students continue to score below international benchmarks, as seen in assessments such as PISA, TIMSS, and the National Achievement Test.

One of the key factors affecting science education in the Philippines is the lack of sufficient teaching-learning resources. Studies show that inadequate resources and teacher support negatively impact student engagement, leading to poor academic performance. Researchers emphasize the importance of instructional materials in facilitating comprehension, fostering engagement, and improving learning outcomes. However, the scarcity, misallocation, and underutilization of these resources contribute to inefficiencies in the education system.

Outdoor learning has gained attention as an effective teaching-learning resource, offering hands-on experiences that enhance students' understanding of scientific concepts. Studies highlight that outdoor environments promote engagement, cooperation, and deeper conceptual learning. While laboratory activities remain the primary mode of experiential learning, outdoor spaces such as parks, markets, and irrigation systems can serve as valuable extensions of the classroom. However, the extent of teachers' awareness and use of outdoor resources in Nueva Vizcaya remains unclear.

To address this gap, the study aims to explore how teachers incorporate outdoor learning into science education and develop a supplementary catalogue of science topics suited for outdoor instruction. By leveraging local environments as learning spaces, the study seeks to

enhance science education in the province, ultimately improving student performance and engagement in the subject.

This study determined the teachers' level of awareness and extent of utilization of outdoor resources in teaching science topics for the school year 2022-2023. Specifically, the study intended to identify the outdoor activities conducted and resources used by the Science teachers; to determine the Science teachers' level of awareness of the use of outdoor resources for teaching science topics; to determine the Science teachers' extent of utilization of outdoor resources for teaching science topics; to describe the best practices of teachers in teaching science; and to develop a supplementary catalogue of outdoor resources in teaching science.

METHODOLOGY

This study employed a mixed-methods approach with a descriptive design to examine the level of awareness and utilization of outdoor resources in teaching science. Researchers collected data through document scanning of teachers' lesson plans and a questionnaire designed to assess awareness, utilization, and best teaching practices. The study's findings were used to develop a supplementary catalogue to enhance outdoor resource integration in science education.

The research was conducted in three private junior high schools in Bayombong, Nueva Vizcaya: Saint Mary's University Junior High School and Science High School, Muir Woods Academy, and Kingsway Christian Academy. These schools were chosen due to their flexibility in lesson planning. The physical environment of each school, including greenery and accessibility, was described to highlight their suitability for outdoor learning.

The study's respondents included seven science teachers from the selected schools, chosen through population sampling. Their academic backgrounds varied, with specializations in Biology, General Science, and Physical Science. Their teaching experience ranged from one to 26 years, with different levels of educational attainment, from bachelor's degrees to doctorates. Notably, none of the respondents had received formal training in utilizing outdoor resources for teaching science.

Data collection involved a structured questionnaire divided into five sections, assessing the teachers' demographics, outdoor teaching resources, awareness, utilization, and best practices. The instrument underwent validation, pilot testing, and reliability testing, with acceptable Cronbach's alpha values indicating strong internal consistency. Additionally, document scanning of lesson plans supplemented the data collection. The analysis was conducted using descriptive statistics for quantitative data and thematic analysis for qualitative responses.

Ethical considerations were addressed through research approval from the Saint Mary's University Research Ethics Board.

RESULTS AND DISCUSSION

Section 1. Utilized Outdoor Resources of Science Teachers

Table 1

Outdoor Resources Used in Teaching Science

Grade Level	Quarter	Content	Hands-On Activity	Outdoor Resources	f
7	2	Microscopy	Microscope Focusing Practice	Plants	4
				School Garden	3
				Soil	1

		Animal and Plant Cells	Microscopic Exploration of Plant and Animal Cells	Plants	5
				School Garden	3
		Ecosystem	Ecosystem Scavenger Hunt	School Garden	7
				Nearby Pond	1
				Nearby Park	1
				Nearby River	0
				Nearby Farm	0
8	4	Heredity: Inheritance and Variation of Traits	Trait Variation Exploration	School Garden	7
				Nearby Flower Farm	2
				Nearby Pet Shop	0
				Nearby Animal Farm	0
				Nearby Park	0
		Biodiversity	Exploring Biodiversity and Taxonomy	School Garden	7
				Nearby Park	1
				Nearby Forest	0
9	1	Heredity: Inheritance and Variation	Trait Scavenger Hunt	School Garden	7
				Nearby Park	1
				Nearby Flower Farm	0
10	4	Biodiversity and Evolution	Evolution Evidence Exploration	School Garden	6
				Nearby Museum	1
				Nearby Park	0

The lesson plans provided by the respondents, obtained through document scanning, were analyzed alongside the responses from the questionnaire. This approach allowed for effective data triangulation, ensuring a comprehensive and reliable analysis. Data in Table 1 highlights a predominant reliance on school gardens, which serve as a critical resource for hands-on activities related to various scientific concepts. For seventh-grade students, the school garden was selected by several teachers for activities such as microscopy and ecosystem exploration. Specifically, 3 teachers identified the school garden as a resource for the "Microscopy Focusing Practice," and another 3 for the exploration of "Animal and Plant Cells." The "Ecosystem Scavenger Hunt" saw the highest selection, with 7 teachers choosing the school garden for this activity. These findings underscore the school garden's effectiveness as a preferred resource for engaging students in scientific inquiry.

For eighth-grade activities, the school garden remained a vital resource, with 7 teachers choosing it for exploring biodiversity and taxonomy. Similarly, 7 teachers selected the school garden for the "Trait Variation Exploration" activity, while nearby flower farms were chosen by only 2 teachers. This preference for the school garden indicates its perceived value among educators for supporting experiential learning. Marchant et al. (2019) emphasize that outdoor learning fosters greater student engagement through experiential pedagogy, offering flexibility compared to traditional classroom settings.

Ninth-grade data further reinforces this pattern, with 7 teachers choosing the school garden for the "Trait Scavenger Hunt." In comparison, nearby flower farms and parks were selected by 0 and 1 teacher, respectively. This consistent reliance on school gardens highlights their accessibility and familiarity as outdoor teaching resources.

In the tenth grade, the school garden was again the most frequently chosen resource, with 6 teachers selecting it for the "Evolution Evidence Exploration." Nearby museums and parks were selected minimally, with only 1 and 0 teachers choosing them, respectively.

In the eighth grade, the school garden continued to be a vital resource, with 7 instances recorded for the exploration of biodiversity and taxonomy. The "Trait Variation Exploration" activity also utilized the school garden 7 times, while nearby flower farms were used only 2 times, indicating a clear preference for the school garden.

The frequent selection of the school garden as a preferred resource may be attributed to its availability and accessibility within the schools. As a readily available facility, the school garden provides a practical and familiar option for educators, making it a convenient choice for

outdoor science activities. This aligns with the study of Maliotou and Liarakou (2022) that states that school garden provides a practical and familiar option for educators, making it a convenient choice

On the other hand, the minimal selection of alternative outdoor resources, such as museums, parks, rivers, and nearby farms, may stem from their limited availability or logistical challenges. These resources, while potentially enriching, often require additional planning, transportation, or permission, which may deter their use in regular teaching practices. These resources, while potentially enriching, often require additional planning, transportation, or permission, which may deter their use in regular teaching practices (Marchant et al., 2019).

To encourage a more diverse use of outdoor learning environments, schools and educators could benefit from partnerships with community institutions, improved access to alternative resources, and professional development opportunities. These initiatives could help bridge the gap between availability and utilization, enabling students to engage with a broader range of outdoor experiences and enhancing the overall quality of science education.

Section 2. Level of Awareness of Teachers in the Use of Outdoor Resources for Teaching Science

Table 2

Awareness of the Outdoor Resources for Teaching Science

Statements	Mean	SD	Level of Awareness
1. The use of outdoor resources makes science learning easier.	3.29	0.49	Moderate
2. The use of outdoor resources provides a positive effect on the benefits of science learning.	3.14	0.38	Moderate
3. Science learning can take place well without the use of outdoor resources.	2.86	0.38	Moderate
4. The use of outdoor resources can make the instruction in science better.	3.29	0.49	Moderate
5. The use of outdoor resources can help the students better understand science topics that are difficult to understand.	3.43	0.53	Moderate
6. The use of outdoor resources has a positive impact on developing learners' appreciation of the environment.	3.29	0.49	Moderate
7. The use of outdoor resources has limited influence on developing a positive attitude towards the environment.	3.29	0.49	Moderate
8. The use of outdoor resources significantly fosters creativity and artistic expression among learners.	3.29	0.49	Moderate
9. Engaging with outdoor resources enhances students' appreciation for the beauty and complexity of nature, inspiring them to think creatively and innovate in their scientific explorations.	3.14	0.38	Moderate
10. The use of outdoor resources does not inspire learners to think creatively.	3.00	0.00	Moderate
11. Students become passive when teachers use outdoor resources in teaching science.	3.00	0.00	Moderate
12. The use of outdoor resources does not increase the interest of students in learning science.	3.00	0.00	Moderate
13. The use of outdoor resources provides opportunities for students to actively engage in science learning.	3.14	0.38	Moderate
14. The use of outdoor resources increases the concentration of students in learning science.	3.14	0.38	Moderate
15. The discussion of science topics can be more meaningful for the students if teachers use outdoor resources.	3.29	0.49	Moderate
Overall	**3.17**	**0.21**	**Moderate**

Legend: 1.00-1.49 (Not Aware), 1.50-2.49 (Aware), 2.50-3.49 (Moderately Aware), 3.50-4.00 (Fully Aware)

The overall mean score of 3.17 (SD = 0.21) categorizes teachers as "moderately aware" of the benefits associated with outdoor resources in science education. This moderate awareness reflects a recognition of the potential advantages of outdoor learning, yet it also indicates areas for improvement in understanding and implementation. The data suggests that teachers acknowledge the role of outdoor resources in making complex science topics more comprehensible, as evidenced by the mean score of 3.43 (SD = 0.53) for the statement regarding

outdoor resources aiding understanding of difficult concepts. Furthermore, the positive impact of outdoor resources on students' appreciation of the environment (Mean = 3.29, SD = 0.49) is consistent with research indicating that outdoor education fosters a deeper connection to nature and environmental stewardship among learners (Pirchio et al., 2021)

The responses to statements regarding outdoor resources not inspiring creativity or increasing student interest (Mean = 3.00, SD = 0.00) reflect a unanimous consensus among respondents, with all participants rating these aspects as "moderately utilized." The standard deviation of 0.00 is particularly significant, as it underscores the complete uniformity of responses, indicating a shared and consistent perspective among teachers regarding the moderate utilization of outdoor resources in this context.

While this uniformity may indicate that teachers generally recognize the potential of outdoor resources, it also suggests that they may not fully realize how to utilize these resources to enhance student engagement and creativity. Ayotte-Beaudet et al. (2017) emphasize that effective outdoor science teaching requires not only awareness but also the development of targeted pedagogical strategies that can transform outdoor experiences into meaningful learning opportunities.

Moreover, the findings indicate that teachers perceive outdoor resources as providing opportunities for active engagement in science learning (Mean = 3.14, SD = 0.38), which is supported by research showing that outdoor settings can enhance student participation (Puhakka, 2021). This aligns with the assertion that outdoor education can lead to improved academic performance and cognitive outcomes, as students are more likely to engage with the material when it is presented in a dynamic and interactive environment (Patchen et al., 2022).

While the findings indicate a moderate level of awareness among science teachers regarding the benefits of outdoor resources, there is a clear need for professional development focused on effective outdoor teaching strategies. By enhancing their understanding of how to utilize outdoor resources to foster creativity and engagement, teachers can better facilitate meaningful science learning experiences for their students. Future research should focus on identifying specific barriers that prevent teachers from fully utilizing outdoor resources and exploring effective training programs that can address these challenges.

Section 3. The Extent of Utilization of Teachers in the Use of Outdoor Resources for Teaching Science

Table 3

Extent of Utilization of the Outdoor Resources for Teaching Science

Statements	Mean	SD	Level of Utilization
1. I regularly incorporate outdoor activities and experiments in my junior high school science lessons.	2.57	0.53	Moderate
2. The integration of outdoor resources is essential for enhancing students' understanding of scientific concepts in my teaching.	3.14	0.38	Moderate
3. I frequently use outdoor environments to engage students in hands-on learning experiences related to science topics.	2.57	0.53	Moderate
4. Utilizing outdoor resources is crucial for enriching the overall science learning experience.	3.14	0.38	Moderate
5. Incorporating outdoor resources significantly contributes to the development of critical thinking and problem-solving skills in science education.	3.14	0.38	Moderate
6. I actively seek opportunities to integrate field trips or outdoor excursions into my science curriculum.	2.71	0.76	Moderate
7. I receive sufficient support and encouragement from my school administration for utilizing outdoor resources in science education.	2.86	0.69	Moderate
8. I am likely to explore additional outdoor resources or educational materials to enhance my science lessons.	3.14	0.38	Moderate
9. Incorporating outdoor resources is highly effective in facilitating student engagement and interest in junior high school science.	3.14	0.38	Moderate

10. The utilization of outdoor resources aligns well with the learning objectives outlined in the junior high school science curriculum.	3.14	0.38	Moderate
11. I feel confident in my ability to plan and execute outdoor science activities for my students.	2.86	0.69	Moderate
12. I regularly adapt my lesson plans to include outdoor learning opportunities	2.71	0.76	Moderate
13. I integrate outdoor resources to address multiple learning modalities (visual, auditory, kinesthetic, etc.)	2.86	0.69	Moderate
14. I regularly update and expand my knowledge in using outdoor resources in my classroom.	2.71	0.76	Moderate
15. Outdoor resources are a primary method for teaching certain science concepts in my classroom.	2.86	0.69	Moderate
Overall	**2.90**	**0.47**	**Moderate**

Legend: 1.00-1.49 (Not Utilized), 1.50-2.49 (Utilized), 2.50-3.49 (Moderately Utilized), 3.50-4.00 (Highly Utilized)

The results indicate that science teachers moderately incorporate outdoor activities into their teaching practices, with an overall mean score of 2.90 (SD = 0.47). This categorization as "moderate" suggests that while outdoor resources are acknowledged as beneficial, there is significant room for improvement in their integration into the science curriculum. The findings reveal that teachers perceive outdoor resources as essential for enhancing students' understanding of scientific concepts, with a mean score of 3.14 (SD = 0.38), which falls under the "moderate" category. This aligns with research that emphasizes the importance of experiential learning in science education. For instance, Byrne et al. (2023) argue that physical experiences closely tied to the content being learned can significantly support students' reasoning and help resolve misconceptions, particularly in the early stages of learning.

Despite the positive perceptions regarding the effectiveness of outdoor resources, the data indicates lower mean scores for the regular incorporation of outdoor activities (Mean = 2.57, SD = 0.53) and the adaptation of lesson plans to include outdoor opportunities (Mean = 2.71, SD = 0.76). Both of these mean scores fall within the "moderate" range, pointing to challenges in consistently incorporating outdoor learning experiences. This discrepancy may reflect barriers such as insufficient support from school administration (Mean = 2.86, SD = 0.69), which also falls under "moderate" category and a lack of confidence among teachers in planning and executing outdoor activities (Mean = 2.86, SD = 0.69). Research by Kim and Lim (2019) supports this, indicating that while field trips and hands-on learning methods can significantly improve students' attitudes and perceptions toward science, their implementation often faces challenges. These barriers may limit the full integration of outdoor activities into science education, despite teachers' recognition of their value

Moreover, the findings suggest that teachers are open to exploring additional outdoor resources, with a mean score of 3.14 (SD = 0.38), which falls under the “moderate” category. This suggests a willingness to enhance their teaching practices by exploring further outdoor resources, which is essential since hands-on learning experiences can improve student engagement and retention of scientific concepts. Additionally, the integration of outdoor resources is also aligned with the learning objectives outlined in the junior high school science curriculum (Mean = 3.14, SD = 0.38), further emphasizing the potential for outdoor learning to fit within existing educational frameworks.

Section 4. Best Practices of Science Teachers

4.1 Hands-on Science Activities

Laboratory Experiments

Laboratory experiments are fundamental in science education as they provide students with opportunities to engage directly with scientific concepts (Katsouli et al., 2023). Respondents highlighted activities like food pH testing and dissections, which allow students to apply theoretical knowledge in practical settings. Additionally, conducting experiments on environmental conditions, such as considering different temperatures in different parts of the campus, underscores the relevance of contextual learning. As one respondent noted,

"Laboratory activities" help reinforce abstract scientific ideas by translating them into hands-on experiences. These approaches not only enhance understanding but also promote critical thinking and problem-solving skills, key competencies in scientific learning.

Physics-Based Outdoor Activities

Physics-based outdoor activities, such as exploring speed, velocity, and acceleration, are essential for demonstrating fundamental principles of physics in real-world contexts. For example, observing and measuring physical phenomena outdoors allows students to actively engage with these concepts in real-world settings. By conducting physics-based experiments outside the classroom, students develop a deeper comprehension of fundamental laws, such as how forces operate in nature. These interactive activities also foster curiosity and analytical thinking, enabling learners to connect classroom theories to everyday life (Fesol et al., 2023).

Engineering and Earth Studies

Engineering and earth studies activities, such as building bridges to understand structural resilience and earthquake dynamics, promote creativity and collaboration. Simulating natural phenomena, like volcanic eruptions, further enhances students' grasp of geological processes. As one respondent noted, these activities are not just about gaining scientific knowledge but also involve applying this knowledge collaboratively. Through hands-on engineering projects, students explore structural mechanics and environmental challenges, building teamwork and communication skills alongside scientific understanding (Idris, 2022).

4.2 Promoting Environmental Awareness and Conservation

Ecosystem Education

Ecosystem education involves teaching students about the relationships between biotic and abiotic components of their environment. Respondents mentioned creative tools like micro-ecosystem posters and biodiversity dioramas to visually represent these relationships. These activities not only engage students creatively but also provide them with a better understanding of ecological balance (Shidiq et al., 2022). As one respondent shared, such lessons are particularly impactful across different grade levels, emphasizing the importance of biodiversity and conservation efforts in science education.

Sustainability Practices

Sustainability-focused activities, such as composting and waste management, help students understand cycles like the nutrient cycle and their implications for environmental health (Ishma & Syaodih, 2021). As noted by respondents, biology-related lessons that focus on biodiversity and caring for the environment are particularly effective in integrating sustainability into the curriculum. Through these activities, students are not just educated about ecological concepts but are also encouraged to adopt environmentally responsible behaviors, thus preparing them to tackle real-world sustainability challenges.

Exploring Nature

Exploring nature provides students with immersive experiences that connect classroom learning to real-world environments. Respondents noted activities like visiting the school garden and observing biodiversity, which allow students to study ecological relationships firsthand. For instance, observing plants and animals in their natural habitats helps students understand concepts such as adaptation, interdependence, and biodiversity (Greig et al., 2024). Simple explorations like these foster critical thinking and curiosity, as students document their observations through reflection logs or worksheets. Such activities instill a deeper appreciation for the natural world and encourage students to see science in action.

4.3 Research and Inquiry-based Learning

Research Projects

Research projects provide students with the opportunity to explore scientific questions independently, cultivating their critical thinking and investigative skills (Montero & Leite, 2022). As noted by one respondent, research work allows learners to delve deeper into specific scientific topics, reinforcing both their theoretical and practical knowledge. Such projects develop essential skills like hypothesis formulation, data collection, and analysis, which are invaluable in scientific inquiry.

Inquiry-based Investigations

Inquiry-based investigations engage students in exploring scientific phenomena by asking questions, conducting experiments, and analyzing results (Burgarso, et al., 2021). Respondents emphasized their value in fostering curiosity and critical thinking, with one noting that inquiry-based outdoor investigations ensure effective integration of teaching and learning. These tasks help students develop a deeper understanding of scientific methods while connecting theory to real-world applications.

4.4 Curriculum Planning, Alignment, and Integration

Contextual Integration

Incorporating outdoor activities based on topic relevance ensures that learning experiences are meaningful. As one respondent shared, "I intend to incorporate outdoor activities if the topic needs one, however, it will still depend on the time." This flexible approach ensures that outdoor learning is not only purposeful but also aligns with broader curricular goals, enhancing student engagement and understanding (Duban, et al., 2019).

Aligning Activities with Learning Objectives

Aligning outdoor activities with learning objectives ensures that they are both effective and relevant (Mendez, 2023). As one respondent explained, identifying objectives and ensuring safety are critical to engaging students in creative, resourceful, and hands-on activities. This alignment bridges the gap between theoretical and practical learning, ensuring a cohesive and impactful educational experience (Mendez, 2023).

4.3 Integrative Assessment

Integrative assessment strategies, such as incorporating outdoor activities into performance tasks, allow educators to evaluate student learning comprehensively (Duban et al., 2019). One respondent mentioned using performance tasks to assess student understanding, which reflects a holistic approach to evaluation. This method not only assesses knowledge but also the application of skills learned through outdoor experiences.

4.5 Student Engagement and Learning Outcomes

Fun and Interactive Outdoor Activities

Outdoor activities are often perceived as more enjoyable and engaging for students (Akarsu, 2015). One respondent noted that students were able to list all the plants and animals they saw during an outdoor activity, highlighting the interactive nature of such experiences. Engaging students in fun and interactive activities fosters a love for learning and encourages exploration.

Collaborative Learning

Collaborative learning activities leverage teamwork to enhance students' understanding of scientific concepts while fostering essential interpersonal skills (Woodham et al., 2016). Respondents highlighted tasks like group-based biodiversity mapping, where students worked together to observe, record, and analyze data. These activities encourage peer-to-peer interaction, shared problem-solving, and a sense of collective responsibility for learning outcomes. As one respondent noted, incorporating collaboration into outdoor tasks makes lessons more dynamic and engaging. This approach not only helps students grasp content better but also prepares them for real-world scenarios requiring teamwork and communication.

Exploratory Activities

Exploratory activities immerse students in discovering their environment through observation and investigation. Respondents mentioned experiences like the *Biodiversity Mapping Expedition* (R7), where students explored nature to identify and analyze various organisms. Such activities promote curiosity and active engagement, encouraging learners to connect scientific concepts with real-world phenomena while fostering a deeper appreciation for their surroundings (Andersen et al., 2022).

In summary, the best practices in teaching and learning science among private school science teachers in Bayombong, Nueva Vizcaya, emphasize the importance of hands-on activities, environmental awareness, inquiry-based learning, curriculum alignment, and student engagement. These practices not only enhance students' understanding of scientific concepts but also foster critical thinking, creativity, and a sense of responsibility towards the environment.

Section 5. Supplementary Catalogue for Teaching Science

The supplementary catalogue is a booklet-style resource that serves as a practical reference for teachers to integrate outdoor activities into their biology lessons. It is designed to assist educators in enhancing student engagement and fostering experiential learning through structured, hands-on approaches.

The catalogue includes the following key elements:

1. Quarter and Content: Each activity is organized according to the academic quarter and the corresponding science content, ensuring alignment with the curriculum.
2. Most Essential Learning Competencies (MELCs): These competencies are clearly outlined to guide teachers in meeting the required learning outcomes for their lessons.
3. Outdoor Resources and Activity Description: The catalogue identifies outdoor resources that can be utilized for each activity and provides a detailed description of the hands-on activity. This includes:
    - Title of the Activity
    - Materials Needed
    - Step-by-Step Procedure
2. Alternative Activities: To accommodate varying classroom contexts or constraints, the catalogue offers alternative activities that teachers can assign to students.
3. Integration with Other Subjects: Activities that overlap with other subjects, such as English or arts, are included, emphasizing interdisciplinary learning and collaboration.

This catalogue is a versatile and user-friendly tool for teachers, enabling them to design meaningful outdoor learning experiences while maintaining curriculum alignment and fostering holistic education.

Conclusion

The study concludes that school gardens serve as the primary outdoor resource for science instruction, facilitating hands-on activities such as microscopy practice, biodiversity studies, and ecosystem exploration. However, alternative resources like parks, farms, and museums remain underutilized. While science teachers exhibit moderate awareness of outdoor resource integration, their application in teaching remains limited due to logistical challenges, lack of confidence, and minimal institutional support.

Despite these challenges, teachers employ best practices such as hands-on learning, inquiry-based activities, and environmental awareness to enhance students' scientific understanding and critical thinking. These methods foster engagement and real-world connections while promoting environmental stewardship.

To address gaps in awareness and utilization, the supplementary catalogue serves as a structured resource that aligns with the curriculum and Most Essential Learning Competencies (MELCs). By offering clear instructions, material lists, and alternative activities, the catalogue aims to enhance experiential learning, improve lesson planning, and encourage cross-disciplinary connections in science education.

Recommendations

To enhance outdoor learning in science education, teachers should expand the use of diverse outdoor resources beyond school gardens, incorporating parks, farms, museums, and natural reserves to enrich students' experiential learning. Professional development programs should be implemented to strengthen teachers' awareness and practical application of outdoor resources, helping them integrate these tools effectively into their lessons.

Schools should provide greater institutional support by allocating time, resources, and logistical assistance for outdoor activities, ensuring that teachers can consistently implement outdoor learning strategies. Teachers are encouraged to continue prioritizing hands-on learning, environmental awareness, and inquiry-based activities, as these methods significantly enhance student engagement and scientific understanding.

The supplementary catalogue should be regularly updated with new activities and innovative outdoor learning ideas, ensuring its relevance to evolving curricular goals. Future research should focus on identifying barriers that limit teachers' use of outdoor resources and assessing training programs designed to address these challenges, ultimately improving science education and fostering a deeper connection between students and the natural world.

REFERENCES

Akarsu, B. (2015). Pre-Service teachers' attitudes towards lab applications in science teaching. *Journal of European Education, 5*(2). https://doi.org/10.18656/jee.33254

Andersen, R., Lekbo, S., Thomsen, L. B., Stephensen, L. M., & Christiansen, L. B. (2022). The creative expedition for science literacy. *Proceedings of Science*, 096. https://doi.org/10.22323/1.418.0096

Ayotte-Beaudet, J., Potvin, P., Lapierre, H. G., & Glackin, M. (2017). Teaching and learning science outdoors in schools' immediate surroundings at K-12 levels: A Meta-Synthesis. *Eurasia Journal of Mathematics Science and Technology Education, 13*(8). https://doi.org/10.12973/eurasia.2017.00833a

Bugarso, J. M. S., Cabantugan, R. E., Tapiculin, Q. D., & Malaco, A. C. (2021). Students' learning experiences and preference in performing science experiments using hands-on and virtual

laboratory. *Indonesian Journal of Teaching in Science, 1*(2), 147–152. https://doi.org/10.17509/ijotis.v1i2.41122

Byrne, E. M., Jensen, H., Thomsen, B. S., & Ramchandani, P. G. (2023). Educational interventions involving physical manipulatives for improving children's learning and development: A scoping review. *Review of Education, 11*(2). https://doi.org/10.1002/rev3.3400

Duban, N., Aydoğdu, B., & Yüksel, A. (2019). Classroom teachers' opinions on science laboratory practices. *Universal Journal of Educational Research, 7*(3), 772–780. https://doi.org/10.13189/ujer.2019.070317

Fesol, S. F. A., Arshad, M. M., & Rusli, N. S. (2023). Youth perception in using virtual reality technology in science learning. *International Journal of Academic Research in Business and Social Sciences, 13*(17). https://doi.org/10.6007/ijarbss/v13-i17/19840

Greig, J. A., Rampold, S., Paskewitz, E., & Ruth, T. (2024). Waving through a window: Agricultural research faculty perspectives on science communication challenges. *PLoS ONE, 19*(6), e0304793. https://doi.org/10.1371/journal.pone.0304793

Idris, M. (2022). Comparative analysis of service supply chain performance using analytic hierarchy process methodology. *International Journal of Engineering Pedagogy (iJEP), 12*(4).

Ishma, N., & Syaodih, E. (2021). Science learning strategies in Islamic kindergarten. *Advances in Social Science, Education and Humanities Research/Advances in Social Science, Education and Humanities Research.* https://doi.org/10.2991/assehr.k.210322.032

Katsouli, M., Giannou, V., & Taoukis, P. (2023). Assessment and evaluation of emergency remote teaching for a project-based assignment on the production of eco-innovative food products – a case study. *International Journal of Food Studies, 12*(1), 1–28. https://doi.org/10.7455/ijfs/12.1.2023.a1

Kim, H., & Lim, C. (2019). Developing a geologic 3D panoramic virtual geological field trip for Mudeung UNESCO global geopark, South Korea. *Episodes, 42*(3), 235–244. https://doi.org/10.18814/epiiugs/2019/019019

Maliotou, M. N., & Liarakou, G. (2022). Teachers' perceptions and educational practices on sustainable nutrition in Cyprus. *Journal of Education for Sustainable Development, 16*(1–2), 61–79. https://doi.org/10.1177/09734082221116858

Marchant, E., Todd, C., Cooksey, R., Dredge, S., Jones, H., Reynolds, D., Stratton, G., Dwyer, R., Lyons, R., & Brophy, S. (2019). Curriculum-based outdoor learning for children aged 9-11: A qualitative analysis of pupils' and teachers' views. *PLoS ONE, 14*(5), e0212242. https://doi.org/10.1371/journal.pone.0212242

Mendez, M. J. (2023). Science laboratory learning environment and students' practices on laboratory safety. *SEAQIS Journal of Science Education, 3*(2), 31–42. https://doi.org/10.58249/sjse.v3i02.113

Montero, C. S., & Leite, L. O. (2022). Towards local community involvement in students' science learning: Perspectives of students and teachers. *Journal of Teaching and Learning, 16*(3), 21–43. https://doi.org/10.22329/jtl.v16i3.6961

Patchen, A. K., Rakow, D. A., Wells, N. M., Hillson, S., & Meredith, G. R. (2022). Barriers to children's outdoor time: teachers' and principals' experiences in elementary schools. *Environmental Education Research, 30*(1), 16–36. https://doi.org/10.1080/13504622.2022.2099530

Pirchio, S., Passiatore, Y., Panno, A., Cipparone, M., & Carrus, G. (2021). The effects of contact with nature during outdoor environmental education on students' wellbeing, connectedness to nature and pro-sociality. *Frontiers in Psychology, 12.* https://doi.org/10.3389/fpsyg.2021.648458

Puhakka, R. (2021). University students' participation in outdoor recreation and the perceived well-being effects of nature. *Journal of Outdoor Recreation and Tourism, 36,* 100425. https://doi.org/10.1016/j.jort.2021.100425

Shidiq, A. S., Permanasari, A., Hernani, & Hendayana, S. (2022). Contemporary hybrid laboratory pedagogy: Construction of a simple spectrophotometer with STEM project-based learning

to introduce systems thinking skills. *Asia Pacific Journal of Educators and Education, 37*(2), 107–146. https://doi.org/10.21315/apjee2022.37.2.6

Woodham, H., Marbach-Ad, G., Downey, G., Tomei, E., & Thompson, K. (2016). Enhancing scientific literacy in the undergraduate cell biology laboratory classroom. *Journal of Microbiology and Biology Education, 17*(3), 458–465. https://doi.org/10.1128/jmbe.v17i3.1162