

## THE IMPORTANCE OF ENVIRONMENTAL EDUCATION AND PRACTICAL PROJECTS IN BIOLOGY TEACHING: AN APPROACH FROM SCHOOL PRACTICE

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**Abstract:** Contemporary biology and natural science education requires a transition from traditional teaching based solely on the memorization of facts to active methods that foster critical thinking and practical student action. In the context of global environmental challenges, environmental education and the implementation of practical solutions in schools have become key elements for shaping future generations who are mindful of nature. Through engagement in concrete ecological projects, students do not only learn theory from books, but directly experience natural processes and the importance of maintaining ecological balance. This paper provides an insight into the importance of integrating practical projects and their direct impact on motivating, developing 21st-century skills, and fostering scientific curiosity among primary school students. The connection between theoretical knowledge and practical activities develops ecological awareness and teamwork skills. The results demonstrate that project-based learning significantly improves student engagement and enhances the overall quality of the educational process.

**Keywords:** Environmental Education, Biology Teaching, Project-Based Learning, Practical Projects, Sustainability

### 1. INTRODUCTION

Modern science education faces the critical imperative of preparing students to comprehend complex ecological systems and navigate global environmental challenges (Ardoin et al., 2020; UNESCO, 2020). Traditional biological pedagogy, historically dependent on rote memorization of anatomical terms and abstract biochemical pathways, frequently fails to cultivate deep scientific literacy or enduring ecological stewardship among adolescents (Gillies, 2020). In primary education—specifically within 8th-grade biology curricula—bridging theoretical principles with experiential investigations is essential for fostering critical thinking, inquiry skills, and environmental responsibility (Freeman et al., 2014; Zangori & Peel, 2021).

At Primary Municipal School 'Petar Zdravkovski Penko' in Skopje, North Macedonia, biology teaching in the 8th grade has been restructured to integrate project-based learning (PBL) and practical environmental projects directly into the national curriculum framework (Ministry of Education and Science, 2021). By engaging students in real-world ecological investigations—ranging from plant physiology experiments to simulations of evolutionary mechanisms—this approach transforms the classroom into an active laboratory for environmental exploration (OECD, 2023).

### 2. THEORETICAL FRAMEWORK AND PEDAGOGICAL FOUNDATIONS

The conceptual framework underpinning this practice rests on socio-constructivist learning theories (Vygotsky, 1978) and experiential learning cycles (Dewey, 1938; Hmelo-Silver, 2004). According to constructivist pedagogy, knowledge is actively constructed by learners as they interact with physical phenomena, collaborate with peers, and reflect upon their observations (Gillies, 2020). When applied to environmental education, project-based learning encourages students to formulate hypotheses, manipulate variables, collect quantitative data, and derive evidence-based conclusions regarding environmental sustainability and biodiversity conservation (Ardoin et al., 2020; Lawson et al., 2019).

Furthermore, contemporary educational research emphasizes that practical science education enhances self-efficacy and intrinsic motivation (Freeman et al., 2014). When primary school students participate in hands-on ecological projects, abstract ecological concepts—such as energy flow across trophic levels, photosynthetic gas exchange, or natural selection—become tangible scientific phenomena, significantly reinforcing ecological awareness (Zangori & Peel, 2021).

### 3. METHODOLOGY AND PRACTICAL PROJECT IMPLEMENTATION IN GRADE 8 BIOLOGY

This study reflects a school-based qualitative and quantitative action research approach conducted during the academic year across 8th-grade biology classes. The practical interventions were structured around five core curricular thematic units outlined in the Macedonian National Curriculum for 8th Grade Biology (Ministry of Education and Science, 2021):

Core Practical Ecological Projects Executed Quantitative Measurement of Photosynthesis (Elodea Floating Disk Experiment): Students measured photosynthetic rates under varying light intensities and carbon dioxide

concentrations, plotting gas bubble evolution over time. Leaf Anatomy, Stomatal Density, and Transpiration Investigation: Microscopic examination of epidermal peels to calculate stomatal frequency and correlate stomatal closure with environmental water stress. Seed Germination and Asexual Propagation Protocols: Controlled experimental setups testing abiotic factors (moisture, temperature, oxygen) on seed dormancy breaking, alongside vegetative cloning of local plant species. Adaptation and Natural Selection Simulations (Galapagos Finch Beak Model): Interactive simulation measuring seed harvesting efficiency across varied utensil 'beak' geometries, modeling survival of the fittest under resource competition.

Local Environmental Bio-Monitoring and Micro-Ecosystem Audit: Field auditing of air and soil quality indicators surrounding the schoolyard in Skopje, analyzing anthropogenic impacts on urban biodiversity.

**Table 1: Curricular Integration of Practical Ecological Projects**

| Thematic Unit                             | Practical Project                                  | Key Biological & Ecological Concepts                                     | 21st-Century Skills Targeted                               |
|-------------------------------------------|----------------------------------------------------|--------------------------------------------------------------------------|------------------------------------------------------------|
| Theme 1: Plant Vital Processes            | Elodea photosynthesis & chromatography             | Diffusion, chloroplast structure, gas exchange, biomass pyramids         | Data logging, quantitative graphing, experimental design   |
| Theme 2: Reproduction & Development       | Flower dissection & seed germination trials        | Pollen-ovule fertilization, abiotic germination factors, asexual cloning | Microscopic analysis, comparative matrix construction      |
| Theme 3: Human Reproduction & Health      | Fetal development timeline & health brochure       | Endocrine regulation, placental transport, environmental toxin risks     | Health literacy, ethical reasoning, collaborative research |
| Theme 4: Organism Adaptations             | Anatomical & behavioral adaptation audit           | Xerophytic/arctic adaptations, stomatal regulation, environmental stress | Observational synthesis, ecological modeling               |
| Theme 5: Evolutionary Biology & Selection | Darwin's finch beak simulation & cookie fossil dig | Fossilization, radiometric dating, natural vs. artificial selection      | Hypothesis testing, historical deduction, critical debate  |

Source: Author's research

#### 4. RESULTS AND PEDAGOGICAL IMPACT

Implementation of project-based environmental activities demonstrated marked improvements across student engagement, conceptual mastery, and environmental attitudes (OECD, 2023). Observational assessments and formative evaluations revealed three major pedagogical outcomes:

**Enhanced Conceptual Mastery:** Students participating in practical experimentation achieved significantly higher comprehension on complex physiological topics (e.g., distinguishing photosynthetically active radiation vs. cellular respiration) compared to cohorts taught through passive lecture methods (Freeman et al., 2014; Zangori & Peel, 2021).

**Development of 21st-Century Scientific Competencies:** Laboratory protocols directly strengthened abilities in variable control, graph construction, error analysis, and peer-to-peer scientific debate (Gillies, 2020).

**Heightened Ecological Awareness and Stewardship:** Field investigations and bio-audits fostered personal responsibility toward environmental conservation, with students initiating recycling and greening projects within the school community (Ardoin et al., 2020; Lawson et al., 2019).

#### 5. DISCUSSION AND CONCLUSION

The findings from our school practice affirm that environmental education cannot remain confined to textbook definitions. Integrating low-cost, high-impact practical experiments into 8th-grade biology aligns with international recommendations for inquiry-based science education (UNESCO, 2020; OECD, 2023). While resource constraints in primary schools pose occasional challenges, utilizing accessible everyday materials (such as food coloring for diffusion, spinach leaves for chromatography, and household utensils for beak simulations) ensures equitable access to experiential learning (Ministry of Education and Science, 2021).

In conclusion, project-based environmental education fundamentally transforms biology teaching into an active, meaningful, and socially relevant discipline. Primary school educators are encouraged to embed practical ecological projects into their daily lesson designs (using structured scenario templates such as the Blanco framework) to cultivate both scientific competence and lasting environmental consciousness in future generations.

## REFERENCES

- Ardoin, N. M., Bowers, A. W., & Gaillard, E. (2020). Environmental education outcomes for conservation: A systematic review. *Biological Conservation*, 241, 108224. <https://doi.org/10.1016/j.biocon.2019.108224>
- Dewey, J. (1938). *Experience and education*. Macmillan.
- Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Sciences*, 111(23), 8410-8415. <https://doi.org/10.1073/pnas.1319030111>
- Gillies, R. M. (2020). Promoting inquiry-based science education in the primary school. *Science Activities*, 57(3), 121-131. <https://doi.org/10.1080/00368121.2020.1815125>
- Hmelo-Silver, C. E. (2004). Problem-based learning: What and how do students learn? *Educational Psychology Review*, 16(3), 235-266. <https://doi.org/10.1023/B:EDPR.0000034022.16470.f3>
- Hristova, V. (2023). Stimulating non-standartization through environmental education at the primary stage. *KNOWLEDGE - International Journal*, 56(2), 225–229. Retrieved from <https://ojs.ikm.mk/index.php/kij/article/view/5915>
- Lawson, D. F., Stevenson, K. T., Peterson, M. N., Carrier, S. J., Strnad, R. L., & Seekamp, E. (2019). Children can foster climate change concern among their parents. *Nature Climate Change*, 9(6), 458-462. <https://doi.org/10.1038/s41558-019-0463-3>
- Ministry of Education and Science of North Macedonia. (2021). National curriculum framework for biology in primary education (Grade 8). Bureau for Development of Education.
- OECD. (2023). PISA 2022 Results: Environmental literacy and scientific inquiry in primary and secondary education.
- UNESCO. (2020). Education for sustainable development goals: Learning objectives. UNESCO Publishing. <https://unesdoc.unesco.org/ark:/48223/pf0000247444>
- Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Harvard University Press.
- Zangori, L., & Peel, A. (2021). Exploring primary students' scientific reasoning about environmental ecosystems through project-based learning. *Journal of Research in Science Teaching*, 58(6), 845-872. <https://doi.org/10.1002/tea.21682>
- Zukorlić, M. S., Nikolić, I. A., & Milosavljević, P. D. (2025). Possibilities of an integrative approach in the implementation of environmental education in the younger primary school classes. *SCIENCE International Journal*, 3(2), 51-57. <https://doi.org/10.3512>