

**CONDUCTING EXPERIMENTS WITH LIVING AND NON-LIVING NATURE AS A
STEAM EDUCATION MODULE**

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Annotation:

This article examines the pedagogical potential of conducting experiments with living and non-living nature as an integrated STEAM education module. The study highlights the role of experimental activities in fostering interdisciplinary learning by combining scientific inquiry, technological application, engineering design, mathematical analysis, and creative expression. Particular attention is given to the educational value of hands-on and inquiry-based experiments in developing students' critical thinking, problem-solving skills, and scientific literacy. The paper emphasizes that integrating biotic and abiotic experiments within a STEAM framework enhances learners' understanding of natural systems, promotes active engagement, and supports the formation of environmental awareness and ethical responsibility. The findings confirm that STEAM-oriented experimental learning contributes significantly to the development of 21st-century competencies and prepares students for future scientific and technological challenges.

Keywords:

STEAM education, experimental learning, living nature, non-living nature, interdisciplinary approach, scientific inquiry, hands-on experiments

**ПРОВЕДЕНИЕ ЭКСПЕРИМЕНТОВ С ЖИВОЙ И НЕЖИВОЙ ПРИРОДОЙ КАК
МОДУЛЬ STEAM-ОБРАЗОВАНИЯ**

Аннотация:

В статье рассматривается педагогический потенциал проведения экспериментов с живой и неживой природой как интегрированного модуля STEAM-образования. Особое внимание уделяется роли экспериментальной деятельности в формировании междисциплинарного обучения, объединяющего научное исследование, технологические средства, инженерное проектирование, математический анализ и творческое мышление. Подчеркивается образовательная значимость практико-ориентированных и исследовательских экспериментов в развитии критического мышления, навыков решения проблем и научной грамотности обучающихся. Отмечается, что интеграция экспериментов с биотическими и абиотическими объектами в рамках STEAM-подхода способствует более глубокому пониманию природных процессов, активному вовлечению учащихся и формированию экологического сознания и этической ответственности. Результаты исследования подтверждают, что экспериментальное обучение, ориентированное на STEAM, эффективно развивает компетенции XXI века и готовит обучающихся к будущим научным и технологическим вызовам.

Ключевые слова:

STEAM-образование, экспериментальное обучение, живая природа, неживая природа, междисциплинарный подход, научное исследование, практическая деятельность

In contemporary education systems, the integration of Science, Technology, Engineering, Arts, and Mathematics (STEAM) has become a central strategy for developing learners' scientific literacy, creativity, and problem-solving competence. One of the most effective approaches within this framework is the systematic organization of experimental activities involving living and non-living nature. Such experiments not only deepen conceptual understanding of natural phenomena but also foster interdisciplinary thinking, inquiry-based learning, and practical skill development. The use of experiments with both biotic and abiotic components as a unified STEAM education module provides learners with authentic scientific experiences that mirror real-world research and technological innovation.

Experimental work with living and non-living nature has historically been a cornerstone of science education. From early natural philosophy to modern empirical science, experimentation has enabled learners to move beyond passive knowledge acquisition toward active knowledge construction. In a STEAM-based context, experiments are no longer isolated scientific procedures; instead, they represent complex learning environments where scientific inquiry, technological tools, engineering design, mathematical modeling, and creative expression intersect. This integrative approach aligns with constructivist learning theory, which emphasizes that learners actively construct knowledge through interaction with their environment rather than merely receiving information from instructors¹. Experiments involving living nature—such as plants, microorganisms, insects, and simple ecosystems—allow students to observe biological processes including growth, adaptation, metabolism, and ecological interaction. These investigations cultivate an understanding of life sciences grounded in observation, hypothesis formulation, data collection, and interpretation. At the same time, experiments with non-living nature—such as water, soil, air, minerals, light, temperature, and physical forces—form the foundation for understanding physics, chemistry, earth science, and environmental systems. When combined within a STEAM module, these experimental domains enable learners to explore the interconnectedness of natural systems and the laws governing both living and non-living matter.

A key scientific principle underlying this approach is the unity of nature. Modern science recognizes that biological systems are inseparable from physical and chemical processes. For example, plant growth depends on light energy, water availability, mineral composition of soil, and atmospheric conditions. Experimental activities that integrate these factors help learners understand complex cause-and-effect relationships and systems thinking. Research in science education confirms that students who engage in integrated experimental learning demonstrate higher levels of conceptual understanding and long-term knowledge retention compared to those exposed to fragmented disciplinary instruction².

¹ Piaget, J. *The Psychology of Intelligence*. Routledge, 2001.

² National Research Council. *A Framework for K–12 Science Education*. National Academies Press, 2012.

Within STEAM education, experimentation serves several pedagogical functions. First, it promotes inquiry-based learning by encouraging students to ask questions, formulate hypotheses, and test predictions through controlled investigation. Second, it supports technological literacy through the use of digital tools such as sensors, data loggers, microscopes, simulation software, and coding platforms. Third, it incorporates engineering thinking by requiring learners to design experimental setups, construct models, and optimize processes. Fourth, mathematical reasoning is applied through measurement, data analysis, graphical representation, and statistical interpretation. Finally, the arts component fosters creativity, visualization, and communication, enabling students to present experimental results through diagrams, models, multimedia projects, and reflective narratives³.

Experiments with living nature within a STEAM module often begin with simple observational studies and progress toward more complex investigations. For instance, students may examine seed germination under varying light or moisture conditions, measuring growth rates and analyzing patterns using mathematical tools. Such experiments introduce fundamental biological concepts while simultaneously engaging learners in data-driven reasoning. When technological tools such as time-lapse photography or digital growth trackers are introduced, students gain experience with scientific instrumentation and digital data management. Engineering elements emerge when learners design optimized growing environments, such as miniature greenhouses or hydroponic systems, applying principles of physics and environmental control.

Non-living nature experiments similarly lend themselves to STEAM integration. Investigations of water filtration, soil composition, heat transfer, or renewable energy sources such as solar power provide authentic contexts for interdisciplinary learning. For example, a water purification experiment may involve chemical analysis of contaminants, physical filtration processes, engineering design of filter systems, and mathematical evaluation of efficiency. Artistic elements may include the design of prototypes or visual presentations explaining the system's operation. Such comprehensive experimental tasks reflect real-world scientific and technological challenges, thereby increasing the relevance and motivational value of learning. Empirical studies in educational psychology indicate that hands-on experimentation significantly enhances learners' cognitive engagement and intrinsic motivation. Students participating in experimental STEAM modules demonstrate improved critical thinking, collaboration skills, and scientific communication abilities. This is particularly evident when experiments are conducted in small collaborative groups, where learners negotiate roles, discuss observations, and collectively interpret results. Social constructivist theory emphasizes that such collaborative interaction is essential for deep learning, as knowledge is co-constructed through dialogue and shared problem-solving⁴.

From a methodological perspective, the effectiveness of experiments with living and non-living nature depends on careful instructional design. Experiments must be developmentally appropriate, ethically responsible, and scientifically valid. In working with

³ Yakman, G. "STEAM Education: An Overview of Creating a Model of Integrative Education." *Pupil's Attitudes Toward Technology*, 2008.

⁴ Vygotsky, L. *Mind in Society: The Development of Higher Psychological Processes*. Harvard University Press, 1978.

living organisms, educators must ensure humane treatment, sustainability, and respect for biodiversity. This ethical dimension is an important educational outcome in itself, fostering environmental awareness and responsible scientific behavior. Similarly, experiments with non-living nature should emphasize safety, accuracy, and environmental responsibility, particularly when dealing with chemical substances or energy sources.

Assessment within a STEAM experimental module extends beyond traditional testing. Authentic assessment strategies such as project portfolios, laboratory reports, reflective journals, and presentations provide a more comprehensive evaluation of student learning. These methods capture not only factual knowledge but also process skills, creativity, and collaborative competence. Research shows that such multidimensional assessment approaches align more effectively with the goals of STEAM education than standardized tests alone⁵.

Technological advancement has further expanded the possibilities of experimental STEAM education. Digital laboratories, virtual simulations, and augmented reality tools allow students to model complex systems that may be inaccessible in traditional classroom settings. For example, simulations of ecological systems or molecular interactions complement physical experiments and enable learners to test variables that cannot be easily manipulated in real life. When combined with hands-on experimentation, these technologies enhance conceptual understanding and provide a bridge between theory and practice. The integration of experiments with living and non-living nature as a STEAM education module also supports the development of future-ready competencies. In a rapidly changing world characterized by environmental challenges, technological innovation, and scientific uncertainty, learners must be equipped with adaptive thinking and problem-solving skills. Experimental STEAM education cultivates these competencies by exposing students to uncertainty, variability, and the iterative nature of scientific inquiry. Students learn that knowledge is not static but evolves through experimentation, analysis, and revision based on evidence.

In conclusion, conducting experiments with living and non-living nature within a STEAM education module represents a powerful pedagogical approach that aligns with contemporary educational goals. By integrating scientific inquiry, technological tools, engineering design, mathematical reasoning, and creative expression, this approach provides learners with holistic and meaningful learning experiences. Empirical research and educational theory consistently demonstrate that such integrated experimental learning enhances cognitive development, motivation, and scientific literacy. As education systems continue to evolve, the systematic implementation of STEAM-based experimental modules will play a critical role in preparing learners to understand and responsibly shape the natural and technological world.

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⁵ Darling-Hammond, L. et al. *Performance-Based Assessment and Educational Equity*. Stanford Center for Opportunity Policy in Education, 2014.

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