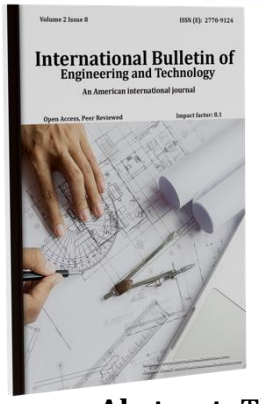

DEVELOPMENT OF STUDENTS' ECOLOGICAL LITERACY THROUGH PRACTICAL EXPERIMENTS IN NATURAL SCIENCE

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Abstract: The article highlights the effectiveness of teaching natural sciences based on practical experience in the development of ecological literacy of primary school students. During the study, a comparison was carried out between the experimental and control groups. The results showed that lessons organized on the basis of practical experience significantly increase students' ecological knowledge, skills, and values. The article also provides recommendations on the advantages of the experimental approach in the formation of ecological behavior, the importance of teacher-family cooperation, and the enrichment of the educational process.

Keywords: primary education, natural science, ecological literacy, practical experience, interactive method.

Introduction

In today's era of rapid globalization and technological development, one of the most important tasks facing humanity is the correct approach to environmental problems and the upbringing of the next generation in the spirit of environmental responsibility. Environmental problems, including air and water pollution, an increase in waste, a decrease in natural resources, and climate change, directly affect human life. In solving these global problems, the formation of ecological literacy from an early age is of decisive importance.

The primary education stage is the period when the fundamental foundation of a child's personality is laid. Therefore, it is necessary to form ecological literacy from primary grades. Because students of this age are interested in feeling nature, directly communicating with the animal and plant world, and quickly assimilate it through experience and observations. If they are involved in activities such as observing nature, conducting ecological experiments, and finding solutions to problematic situations during the learning process, they will develop a sense of love, care, and responsibility towards nature along with ecological knowledge.

In recent years, the development of environmental education and literacy in the field of education in the Republic of Uzbekistan has been elevated to the level of state policy. In particular, the national project "Yashil Makon," the "Concept of Environmental Education," and the laws "On Environmental Protection" define strengthening the environmental education of students as an important task. In this regard, natural science lessons at school are one of the main tools for the formation of environmental awareness and ecological culture.

If natural sciences are accepted only as theoretical knowledge without practical experience, the topic often becomes abstract for the reader. The use of practical experience allows the student to:

–connect knowledge with real-life examples through observation, experimentation, and testing ,

–drawing scientific conclusions based on one's own experience ,

–provides the opportunity to understand and solve environmental problems.

Thus, the experimental approach serves as an important methodological basis for the development of environmental literacy.

The process of forming environmental literacy is based on a constructivist approach, the theory of experimental learning (Kolb, 1984), and the 5E model (Bybee et al., 2006). This model allows for the phased implementation of the following during the lesson:

- ❖ Engage (Involve) - interest students in problems and questions;
- ❖ Explore - study the problem through practical experience;
- ❖ Explain (Explanation) - scientific explanation of observed phenomena;
- ❖ Elaborate (Expanding) - applying new knowledge to real-life situations;
- ❖ Evaluate - analyze knowledge and skills and determine the level of mastery.

Especially in primary grades, through this model, students can be involved in activities such as observing nature, performing simple experiments on purifying water, air, and soil, sorting waste, and finding solutions to environmental problems at home and in the classroom. Although it is necessary to form students' environmental literacy through practical experience, this process has not yet been sufficiently established in school practice. Environmental knowledge is often imparted to students only in theoretical form, while experiments are rarely applied. As a result, students:

–linking environmental problems to real life,

–Independent analysis and tracking,

–Sustainable behaviors (such as water conservation, waste sorting) are not sufficiently developed.

Therefore, the main problem of the research is: how effective is it to develop the environmental literacy of elementary school students through practical experiments in natural sciences?

The purpose of this scientific work is to determine the effectiveness of the development of ecological literacy of primary school students based on practical experience in natural science lessons.

Tasks:

- ✓ Analysis of the theoretical foundations of the formation of ecological literacy in primary grades.
- ✓ Development of a set of practical experiences aimed at forming ecological knowledge, skills, and values in students.
- ✓ Integration of experiments into the lesson process based on the 5E model.
- ✓ Determination of changes in the level of ecological literacy of students based on experiments.
- ✓ Development of methodological recommendations for primary school teachers based on the research results.

If practical experiments are used regularly and systematically in natural science lessons, the level of environmental literacy of primary school students, i.e., knowledge, skills, and attitude, will increase significantly.

As a result of the study:

- ✓ A set of appropriate environmental experiments will be developed for primary school students;

✓ the effectiveness of experimental lessons based on the 5E model in the development of environmental literacy is proven;

✓ Methodological recommendations are proposed for primary school teachers.

From a practical point of view, these results serve the formation of students as ecologically conscious, responsible individuals for the preservation of nature.

Literature analysis and methods

The concept of environmental literacy has become one of the main directions of the global education system in recent years. According to UNESCO (2017) , environmental education plays a key role in achieving the Sustainable Development Goals (SDG-4 and SDG-13). Especially at the stage of primary education, the formation of environmental awareness is a strategic factor in building a sustainable society.

Kolb (1984) , is widely used in environmental education. According to it, the student acquires new knowledge not only by studying a ready-made theory, but also through the cycle experiment - observation - analysis - generalization. This approach is especially important for elementary school students, as they are close to the "touch-and-learn" approach.

The 5E model (Engage, Explore, Explain, Elaborate, Evaluate), developed by Bybee et al. (2006), is one of the effective methods for developing environmental literacy in the teaching of natural sciences. This model involves the student as an active researcher and allows organizing the learning process in systematic, logical stages.

Bowers (2001) emphasizes that the goal of environmental education is not only to form knowledge about nature, but also to help review the relationship between humans and nature. This idea is very important for elementary school students: if they form a correct attitude towards nature from an early age, then in the future a stable lifestyle will become their habitual behavior.

In Uzbekistan, the issue of developing environmental literacy has also been elevated to the level of state policy. Sobolev (2020) in his research proved that the use of ecological experiments in natural sciences strengthens students' awareness of environmental protection. Joldasov and Tursunova (2023) , using the 5E model, note an increased level of interest and participation in environmental projects among schoolchildren.

Thus, the analysis of the available literature shows that:

–the formation of ecological literacy in primary grades is an urgent task;

–practical experience and interactive methods are recognized as the most effective means of environmental education;

–The 5E model and the theory of experimental learning are suitable for the conditions of primary education and allow the development of environmental awareness in students.

Methods

This study aimed at studying the development of ecological literacy of primary school students through practical experience in natural sciences, using the following methods:

1. Study participants

The experiment was conducted in the 4th grade of secondary school No. 29 of the Yangiaryk district of the Khorezm region. A total of 55 students participated in the study. They were divided into two groups:

Experimental group (28 students) - natural science lessons were organized based on practical experience.

Control group (27 students) - lessons were conducted in the traditional (more theoretical) style.

2. Research design

The study was conducted over a 6-week cycle. There were 2 hours of science lessons per week, a total of 12 lessons were conducted. In the experimental group, each lesson was built on the 5E model.

3. Content of practical experiments

A special set of ecological experiments has been developed for students. Some of them:
Water purification experiment: Filtering soil water using sand, stone, and cotton.
Plant Photosynthesis: Observing the leaf in the sun and shade, demonstrating the release of oxygen using a simple container.

Waste sorting: Discuss the possibility of separate collection and recycling of plastic, paper, and organic waste.
Water Saving Experiment: Comparing the flow rate using the tap open and closed.

4. Criteria for assessing environmental literacy

The level of students' environmental literacy was assessed according to three components:

Knowledge - theoretical knowledge about nature, environmental problems, resource conservation.

Skills - conducting experiments, observing, drawing conclusions, applying methods for solving environmental problems.

Discussion and attitude - care for nature, environmental responsibility, sustainable behavior (e.g., waste disposal, water conservation).
Questionnaires, observation sheets, and test taskshave been developed for assessment.

5. Stages of research

Preliminary diagnostics - at the beginning of the study, the level of environmental literacy of students is determined by tests and questionnaires.
Experiment - classes based on practical experiments will be conducted in the experimental group for 6 weeks.

Final diagnostics - at the end of the study, repeated tests and questionnaires are conducted, and the results are compared.

6. Data analysis

The results were analyzed using percentage indicators, average scores, and statistical comparison (t-test) . These methods made it possible to scientifically identify differences between the experimental and control groups.
Results

During the study, the level of environmental literacy of students of the experimental and control groups was compared according to three main criteria - knowledge, skills, and attitude. According to the results of the preliminary diagnostics, the initial levels of the two groups of students were practically the same, and no significant difference was observed.

4.1. Knowledge Level Results

At the end of the experiment, the level of environmental knowledge of the students of the experimental group increased significantly.

Before the experiment, only 32% of students in the group were able to fully answer about the importance of environmental protection, waste recycling, or water conservation, while after the experiment, this indicator reached 78%.

In the control group, this indicator increased only from 36% to 45%.

This shows that through practical experiments, students understood the topic not in a theoretical form, but through real examples.

4.2. Skill Level Results

Students of the experimental group participated in the practical classes with high activity and interest.

In the "Water Treatment Experiment," 85% of students performed the experiment independently and explained the process.

In the "Garbage Sorting" lesson, 90% students correctly separated waste and demonstrated recycling capabilities.

When analyzing the results of the "photosynthesis observation," the student was able to independently draw a scientific conclusion.

The level of skill development in the control group remained low - only 40-50% of students were able to fully complete the tasks.

4.3. Results of attitudes and behavior

In the experimental group, the most important component of environmental literacy - attitude towards nature - changed significantly for the better.

At the beginning of the study, only 28% of students noted the habit of throwing garbage in the classroom, and at the end of the experiment, this indicator reached 72%.

In observing water-saving habits, 65% of students consciously changed their behavior during the experiment.

According to the results of the questionnaire representing "love for nature" and "environmental responsibility," 81% of students in the experimental group assessed nature conservation as "my duty" (in the control group only 42%).

4.4. Results of statistical analysis

The data were verified by means of testing.

The overall score of the experimental group averaged 76.4%, and the result of the control group was 47.8%.

Statistical calculations revealed a significant difference at the $p < 0.05$ level.

These results scientifically confirm that students achieved significantly higher results in environmental knowledge, skills, and attitudes through practical experiments.

Consideration

The results of the study showed that lessons based on practical experience are significantly more effective in developing the environmental literacy of primary school students than traditional theoretical lessons.

5.1. Increase in knowledge

A sharp increase in the level of knowledge in the experimental group (from 32% to 78%) proves that students thoroughly master environmental concepts not only by hearing, but also through practical experience by seeing, feeling, and participating. This result fully corresponds to the experimental reading theory of Kolb (1984) . Therefore, the active participation of the student in the formation of ecological knowledge plays an important role.

5.2. Skills and practical activity

Students conducted independent work during the experiments. They had the opportunity to connect the theory learned in the process of water purification, waste sorting, or observing photosynthesis with practice. This served to develop their research abilities. In the control group, due to the insufficiency of this opportunity, fewer skills were formed. This result is consistent with the scientific findings of Bybee et al. (2006) on the effectiveness of the 5E model.

5.3. Attitude and stable behavior

One of the important aspects is the formation of ecological behavior in students. In the experimental group, the majority of students perceived the preservation of nature as a "personal duty," which confirms the idea put forward by Bowers (2001) of one of the main tasks of environmental education - the restructuring of the relationship between man and nature. These changes show not only knowledge but also the formation of value and a sense of responsibility.

5.4. Reasons for the effectiveness of practical experiments

The analysis shows that practical experience in the development of environmental literacy is effective for the following reasons:

Suitability for visual and kinesthetic learning - younger students grasp the topic by touching, seeing, and observing.

Increasing interest - experiences become gamelike and exploratory for students, which increases their motivation.

Ensuring active participation - each student actively participates in the lesson process, becoming a researcher, not a passive listener.

Formation of stable behavior - simple habits (water conservation, proper waste disposal) are formed faster in children and are transferred to everyday life.

5.5. Significance of the research

The obtained results are important not only for primary school students, but also for the school education system:

The necessity of introducing more practical experiments into natural science lessons was substantiated.

Ecological consciousness, formed in primary school, can be strengthened in subsequent stages of education.

Students become active actors in promoting ecological habits within their families and communities.

5.6. Limitations and Prospects

The study has some limitations:

The study was conducted on the example of a single school; a broader sample can give more reliable results.

The results included a short-term period, the long-term effect should be monitored.

In the future, the study can be conducted in different regions, in different age groups, and by comparing different methods.

Result

The research results showed that in the development of environmental literacy of primary school students, teaching natural sciences based on practical experience has high effectiveness.

Students' knowledge has significantly increased - they have thoroughly mastered environmental concepts not only through theoretical but also through practical activities.
Skills were formed - they became ready for environmental activities by independently performing simple experiments, such as water purification, waste sorting, plant care.
Students developed positive attitudes and ecological values - understanding nature conservation as a personal duty, water conservation, and proper waste disposal became habits.
In general, it has been scientifically proven that education, organized on the basis of practical experience, is an effective tool for the development of environmental literacy. This approach is fully consistent with Kolb's (1984) experimental learning model and Bybee et al.'s (2006) 5E model and aligns with the Sustainable Development Goals put forward by UNESCO (2017).
Suggestions

Regular inclusion of practical experiments in elementary school natural science lessons - teaching students not only with theoretical knowledge, but also through direct experiments and observations.

Continuing environmental projects and small assignments at home - encouraging practical activities in the family, such as water conservation, waste sorting, or planting.
Using interactive methods - the 5E model, conducting experiments in small groups, keeping an observation diary encourages active participation of students.
Teacher Training and Enrichment of Methodological Guides - Increase the number of lesson plans, experimental collections, and didactic tools aimed at developing environmental literacy.
Strengthening cooperation between school, family, and community - environmental habits formed in children will yield sustainable results if they are supported not only at school, but also in the family and social environment.

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