BG Pulse Journal USA
ISSN:1947-2536 http://www.bgpulseusa.com/index.php/bg
BG PULSE JOURNAL

PEDAGOGICAL PRINCIPLES FOR DEVELOPING STUDENTS' RESEARCH SKILLS THROUGH PRACTICAL WORK IN BIOLOGY EDUCATION

Saparov Kalandar Abdullaevich
Professor, Doctor of Biological Sciences,
Professor of the Department of Biology, Faculty of Natural Sciences,
Nizami National Pedagogical University of Uzbekistan.

Ochilov Eldor Utkir ugli
Head of the Biology Department, Republican Education Center under the
Ministry of Preschool and School Education, Independent Researcher,
Nizami National Pedagogical University of Uzbekistan

Doi: https://doi.org/10.5281/zenodo.21294897

Abstract: The development of students' research skills is an important task of modern biology education. Biology lessons provide wide opportunities for observation, experimentation, evidence-based reasoning and practical application of scientific knowledge. However, these opportunities become effective only when practical work is organized as a purposeful inquiry-oriented activity. This article analyzes the pedagogical principles for developing students' research skills through practical work in secondary school biology education. The study is based on theoretical and methodological analysis of pedagogical literature, biology teaching methodology, normative documents and teaching practice. The article identifies the key principles of research-oriented practical work: scientific validity, systematicity, accessibility, integration, practical orientation and independent activity. These principles are connected with search-oriented, analytical, communicative, reflective and functional components of students' learning. The findings may be used in designing biology practical tasks, laboratory activities and methodological recommendations for teachers.

Keywords: biology education; practical work; research skills; inquiry-based learning; pedagogical principles; secondary education.

1. Introduction

Research skills are necessary for students to understand biological phenomena, work with evidence and apply scientific knowledge in practical situations. In science education, inquiry-based learning helps students formulate questions, observe phenomena, collect evidence and construct explanations [1]. Practical and laboratory work also strengthens the connection between theoretical knowledge and real learning experience [2].

Biology has strong potential for this process because it deals with living organisms, ecosystems, human health and environmental problems. Students can observe biological objects, compare structures, conduct simple experiments, interpret data and explain natural processes. However, if practical work is limited to mechanical completion of instructions, its developmental

effect remains weak. It becomes effective when students are involved in problem identification, observation, evidence recording, analysis and reflection [3].

The modernization of science education in Uzbekistan also requires the strengthening of practical and research-oriented learning. National education policy documents emphasize the need to improve the quality of general education and the practical orientation of chemistry and biology teaching [4, 5]. Therefore, defining the pedagogical principles of organizing biology practical work is methodologically important. The aim of this article is to clarify the pedagogical principles for developing students' research skills through practical work in biology education.

2. Methodology

The article is based on conceptual and methodological analysis. Pedagogical, psychological and methodological literature on inquiry-based learning, practical work, biology teaching and students' research activity was analyzed. Normative documents related to general secondary education and science teaching were also examined.

The analysis focused on three issues: the role of practical work in developing research skills, the principles that guide its organization, and the didactic components of students' inquiry-oriented activity. In this article, practical work is understood as a structured learning process that includes problem identification, observation or experimentation, evidence recording, interpretation of results and reflection. This interpretation is consistent with approaches that consider learning as an active process based on experience, action and reflection [6, 7].

3. Results and Discussion

Practical work in biology should not be considered only as a means of consolidating theoretical knowledge. It should function as a didactic mechanism for developing students' scientific thinking, independence and research behavior. Such work develops observation, accuracy, evidence-based reasoning, cooperation and responsibility.

The main pedagogical principles for organizing research-oriented practical work are presented below.

Principle	Meaning in biology education
Scientific validity	Practical tasks must be based on scientifically correct biological concepts and evidence.
Systematicity	Tasks should move from simple observation to analysis, explanation and conclusion.
Accessibility	Content, materials and instructions should correspond to students' age and prior knowledge.
Integration	Practical work should connect biology with ecology, chemistry, mathematics,

	health and real life.
Practical orientation	Biological knowledge should be applied to natural, environmental and everyday situations.
Independent activity	Students should gradually move from teacher-guided work to independent inquiry.

These principles are effective only when they are applied as a system. Scientific validity without accessibility may make practical work too difficult, while accessibility without scientific validity may reduce its educational value. Similarly, practical orientation becomes meaningful when it is connected with systematicity and independent student activity.

The development of research skills also requires several didactic components. The **search-oriented component** develops the ability to identify a problem and ask questions. The **analytical component** develops comparison, classification and interpretation of data. The **communicative component** supports discussion, explanation and presentation of conclusions. The **reflective component** helps students evaluate their own activity. The **functional component** connects biological knowledge with real-life application.

In biology lessons, these components may be implemented through tasks such as observing plant growth, comparing biological objects, analyzing ecological situations, interpreting tables and diagrams, or explaining the results of simple experiments. In each case, students should not merely perform actions, but understand the purpose of the task and justify their conclusions through evidence.

The teacher's role is to organize the learning process, guide students' inquiry and create conditions for independent thinking. Practical work should include four basic stages: motivation and problem setting; performance of practical activity; analysis of evidence; reflection and conclusion. Such organization corresponds to biology teaching methodology, where practical and laboratory activities are considered important means of forming biological concepts and skills [8, 9].

4. Limitations

This article is conceptual and methodological in nature. It systematizes pedagogical principles and didactic components for organizing research-oriented practical work in biology education, but it does not present separate empirical data. Further studies may test the effectiveness of these principles in different grades, topics and school contexts through experimental research.

5. Conclusion

The development of students' research skills is one of the important directions of improving biology education. Practical work has strong pedagogical potential because it connects biological knowledge with observation, experimentation, evidence and reflection. This potential is realized when practical work is organized on the basis of scientific validity, systematicity, accessibility, integration, practical orientation and independent activity.

The proposed approach shows that biology practical work should be designed not only around procedures, but also around biological problems, evidence analysis and student reflection. Such organization helps students understand biological concepts more deeply, apply knowledge in practical situations and develop research-oriented thinking.

References

1. National Research Council. *Inquiry and the National Science Education Standards: A Guide for Teaching and Learning*. Washington, DC: National Academy Press; 2000.
2. Hofstein A, Lunetta VN. The laboratory in science education: Foundations for the twenty-first century. *Science Education*. 2004;88(1):28–54.
3. Hmelo-Silver CE, Duncan RG, Chinn CA. Scaffolding and achievement in problem-based and inquiry learning. *Educational Psychologist*. 2007;42(2):99–107.
4. Decree of the President of the Republic of Uzbekistan No. PF–5712. *On approval of the Concept for the Development of the Public Education System of the Republic of Uzbekistan until 2030*. Tashkent; 2019.
5. Resolution of the President of the Republic of Uzbekistan No. PQ–4805. *On measures to improve the quality of continuous education and the effectiveness of science in chemistry and biology*. Tashkent; 2020.
6. Minner DD, Levy AJ, Century J. Inquiry-based science instruction: What is it and does it matter? *Journal of Research in Science Teaching*. 2010;47(4):474–496.
7. Dewey J. *Experience and Education*. New York: Macmillan; 1938.
8. G‘ofurov AT, Tolipova JO, Fayzullayev SS, Azimov IT, Axmadaliyeva B. *Biologiya o‘qitishning umumiy metodikasi*. Tashkent; 2005.
9. Tolipova JO. *Biologiyani o‘qitishda innovatsion texnologiyalar*. Tashkent; 2014.