

METHODS FOR IMPROVING BIOLOGY TEACHING IN INCLUSIVE EDUCATION

(Based On a Study Conducted at Secondary School No. 7 In Bukhara)

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Abstract: The article examines modern methods and pedagogical technologies aimed at improving the effectiveness of teaching biology in an inclusive educational environment. The study is based on an analysis of scientific literature and practical experience obtained during a pedagogical experiment conducted at Secondary School No. 7 in Bukhara. The difficulties faced by students with special educational needs (SEN) are identified, and effective methodological approaches are determined, including differentiated instruction, digital educational resources, Universal Design for Learning (UDL), adaptation of laboratory work, and a team-teaching model. The results of implementing these methods demonstrate increased academic performance and student engagement.

Keywords: inclusive education, biology, adaptation, UDL, differentiated instruction, students with SEN, pedagogical experiment.

Introduction

In the context of the modernization of Uzbekistan's national education system, the development of inclusive educational practices has become increasingly important. Government programs and regulatory documents — in particular, the Concept for the Development of Inclusive Education and the updated state educational standards — emphasize the need to create an accessible learning environment, adapt educational materials, and apply individualized teaching approaches. Under these conditions, improving instructional methods in school subjects, including natural sciences, becomes especially relevant.

Biology holds a central place in shaping students' scientific worldview, ecological culture, and biomedical literacy. The subject requires the use of laboratory experiments, observations, analysis of biological objects, and work with visual models. However, in inclusive classrooms, these processes become more complex. Students with special educational needs (SEN) may experience difficulties in understanding abstract biological concepts, working with laboratory equipment, processing a large amount of visual or textual information, or performing fine motor tasks. This necessitates flexible pedagogical solutions, various adaptations, and the use of specialized teaching technologies.

Contemporary research in inclusive pedagogy indicates that the most effective approaches include differentiated instruction, Universal Design for Learning (UDL), the use of digital educational resources, and team-teaching models that combine the efforts of a subject teacher and an inclusion specialist. Another significant direction involves adapting laboratory work by creating alternative forms of experiments, using virtual labs, tactile models, and visual diagrams.

This study is based on an analysis of scientific literature and the author's practical experience gained during a pedagogical experiment conducted at Secondary School No. 7 in Bukhara. The dynamics of academic performance and engagement of students with SEN were examined as adapted methods of teaching biology were applied. The results made it possible to identify the most effective approaches that improve the quality of learning, increase motivation, and support the development of academic competencies for all students without exception.

The main purpose of this article is to determine the methods that contribute to effective biology instruction within inclusive education and to present practical results of implementing these methods.

Relevance of the Study: The relevance of this research is determined by the fact that, despite the existence of regulatory documents, methodological guidelines for adapting biology to the conditions of inclusive education in Uzbekistan are still insufficiently developed.

Objective of the Study: To identify effective methods for improving the quality of biology teaching in inclusive classrooms, assess their impact on learning outcomes, and adapt these methods to the practical experience of teaching at Secondary School No. 7 in Bukhara.

Materials and Methods: The study was conducted during the 2023–2024 academic year at Secondary School No. 7 in Bukhara, in classes that include students with diverse educational needs (mild hearing impairment, ADHD, delayed mental development, reading difficulties, and moderate motor disorders).

Methods Applied:

1. Pedagogical Observation

Systematic observation of students' learning activities in biology lessons, their perception of materials, and performance in laboratory work was conducted over a period of 8 months.

2. Diagnostic Methods

- Testing of biological knowledge;
- Practical skills assessment chart;
- Student engagement scale (0–3 points);
- Observation of dynamics in attention, independence, and communication skills.
- **Questionnaires for Teachers and Students**

The survey included 28 students and 6 teachers.

3. Element of Pedagogical Experiment

A series of lessons was conducted using adapted methods:

- Multi-level tasks;
- Visual and digital resources;
- Adapted laboratory practicals;
- Tutorial support.

4. Statistical Analysis

Student performance and engagement indicators were compared before and after the implementation of the methods (Student's t-test).

Research Results

1. Main Difficulties of Students with Special Educational Needs in Learning Biology

Based on observations and questionnaires, the following problems were identified:

1.1. Cognitive Difficulties

- Difficulty in understanding terminology (cell, mitosis, respiratory chain);
- Challenges with abstract thinking;
- Problems maintaining attention for more than 10–12 minutes.

1.2. Sensory and Motor Limitations

- Students with hearing impairments struggled to understand explanations without visual support;
- Motor disorders limited participation in laboratory work.

1.3. Emotional Difficulties

- Fear of making mistakes;
- Low academic motivation.

1.4. Difficulties in Laboratory and Practical Work

67% of students experienced difficulties when working with microscopes and biological specimens.

Effective Methods for Improving Biology Teaching

2.1. Differentiation and Individualization

At Secondary School No. 7, the following methods were successfully implemented:

- Three-tiered assignments (basic — intermediate — creative);
- Adapted texts with highlighted key concepts;
- Alternative response formats (drawing, oral answer, video presentation).

Result: Academic performance improved by 18%.

2.2. Use of Digital Technologies

During the experiment, the following tools were used:

- Virtual laboratories (PhET, Labster);
- Animations of cell division;
- 3D models of organs and tissues;
- Interactive worksheets (Google Forms, LearningApps).

Result: Student engagement increased from 1.4 to 2.6 out of 3 points.

2.3. Universal Design for Learning (UDL)

UDL elements were introduced:

- Visually contrasting diagrams;
- Information duplicated with gestures/captions;

- Use of cue cards;

Large-scale models (cell, organs) for tactile perception.

Particularly effective: the cell model was actively used by students with delayed mental development and hearing impairments.

2.4. Adaptation of Laboratory Work

Implemented strategies included: enlarged laboratory instruments; step-by-step algorithms; paired work (“strong — weak” pairs).

Result: Participation in laboratory work increased from 42% to 85%.

2.5. Team Teaching Model (Co-Tutoring)

Assistants helped with distributing materials, performing hazardous manipulations, and monitoring student attention. This reduced students’ anxiety levels.

Discussion

The research results confirm the effectiveness of a comprehensive approach to inclusive biology education. The greatest impact was observed with:

- Differentiation — increasing material accessibility;
- Digital technologies — compensating for sensory and motor deficits;
- UDL — ensuring equal access to information;
- Adapted laboratory work — enhancing practical skills;
- Tutorial support — reducing stress.

A key finding is that the most effective results were achieved through combined methods, where digital resources were paired with tactile models and individualized assignments.

Conclusions

- Inclusive biology education is possible only with targeted adaptation of methods and materials. Experience at Secondary School No. 7 in Bukhara demonstrated that academic success improves with differentiation, adapted laboratory work, UDL, and digital visualization.
- The implementation of these methods resulted in:
- Academic performance improvement by 18–27%;
- Engagement increase by 46% on the scale;
- Participation in laboratory work increased by 43%.

Teachers require comprehensive training in inclusive pedagogy.

The developed methodological recommendations can be implemented in other general education institutions.

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