

EXPERIMENTAL RESULTS OF DEVELOPING STUDENTS' BIOLOGY-RELATED COMPETENCIES BASED ON A SYNERGETIC APPROACH

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Abstract: *The article analyzes the pedagogical effectiveness of developing students' subject-specific competencies based on a synergetic approach in teaching biology in general secondary schools. The experimental study was conducted in general secondary schools of the Samarkand, Navoi, and Bukhara regions with the participation of 697 students. The research results were analyzed using the Student–Fisher criterion, which made it possible to scientifically substantiate a 13.4% increase in the effectiveness of biology teaching through the application of the synergetic approach.*

Keywords: *synergetic approach, biology education, competency, experimental study, pedagogical effectiveness, statistical analysis.*

INTRODUCTION

Currently, the reforms being implemented in the education system require the introduction of substantively renewed education based on a competency-based approach. In particular, in teaching biology, the formation of students' competencies related to understanding natural phenomena, analyzing biological processes, developing ecological culture, and promoting a healthy lifestyle is one of the most pressing issues [1].

Modern pedagogical research shows that high learning outcomes can be achieved by organizing the educational process as a complex and open system.

From this perspective, the synergetic approach contributes to increasing students' cognitive activity, developing independent thinking, and ensuring the systematic acquisition of knowledge in the process of biology education [2]. The purpose of this article is to scientifically analyze the results of experimental research conducted to develop students' subject-specific competencies based on a synergetic approach in teaching biology.

Research Methodology. In the course of the study, the following scientific and pedagogical methods were used: pedagogical observation, interviews, testing, experimental work, and methods of mathematical and statistical analysis [3,10]. The experimental study was carried out in General Secondary School No. 3 of Pakhtachi District (Samarkand region), General Secondary School No. 12 of Navoi city (Navoi region), and General Secondary School No. 3 of Bukhara District (Bukhara region). A total of 697 students studying biology participated in the research.

The students were divided into experimental and control groups. In the control groups, biology lessons were conducted using traditional teaching methods, whereas in the experimental groups, interactive methods based on the synergetic approach, problem-based learning, project-based activities, and reflection techniques were implemented [4,8,9].

The composition of students participating in the experimental study is presented in 1-Table

Composition of Students Participating in the Experimental Study

No	Region	Educational Institution	Experimental Group (number)	Control Group (number)	Total
1	Samarkand Region	Secondary School No. 3, Pakhtachi District	118	115	233
2	Navoi Region	Secondary School No. 12, Navoi City	121	119	240
3	Bukhara Region	Secondary School No. 3, Bukhara District	112	112	224
Total			351	346	697

The Role of the Synergetic Approach in Biology Education The synergetic approach involves organizing the educational process as a holistic system consisting of interrelated elements. In teaching biology, this approach enables the formation of students' knowledge based on interdisciplinary integration [5,6,7]. In the experimental classes, biological concepts were studied in close connection with ecology, geography, chemistry, and medicine. This contributed to a deeper understanding of biological processes by students and helped them relate these processes to real-life situations.

Experimental Results and Their Analysis During the experimental work, students' knowledge, skills, and competencies in biology were systematically assessed. The results of the final assessment showed that the average performance indicators of students in the experimental groups were higher than those of the control groups. The results of the pedagogical experimental work conducted in general secondary schools are presented. This table presents the results of pedagogical experimental work conducted across all general secondary schools, comparing changes in students' performance levels in experimental and control groups from the beginning to the end of the experiment.

Reliable Analysis of the Obtained Results To ensure a reliable analysis of the obtained results, the Student-Fisher criterion was applied. Using this criterion, the statistical significance of the difference between the experimental and control groups' results was confirmed [6,10]. According to the mathematical and statistical analysis, biology lessons organized based on the synergetic approach increased educational effectiveness by 13.4%. This result confirmed the correctness of the research hypothesis.

Discussion of the Results The experimental results showed that the synergetic approach enhances students' cognitive activity in biology, guides them towards independent learning, and serves as an effective tool for developing competencies [2]. Students in the experimental groups demonstrated the development of ecological thinking,

knowledge related to a healthy lifestyle, and a conscious understanding of biological processes.

This also highlights the educational significance of the synergetic approach [1].

Conclusion

The results of the conducted research demonstrated that using the synergetic approach in teaching biology is pedagogically effective.

The experimental work showed significant positive changes in students' development of biology-related competencies.

Analyses based on the Student–Fisher criterion confirmed that the difference between experimental and control groups was statistically significant, and the synergetic approach ensured a 13.4% increase in effectiveness.

These results have important scientific and practical implications for improving the methodology of teaching biology.

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