

Evaluation of the effectiveness of innovative methods in biology teaching

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Abstract. The goal of our research work is to study the effectiveness of innovative methods of teaching biology. It is difficult to keep the attention of modern students in one direction, because social networks, society, and the development of time are affecting it. Innovative teaching methods increase the student's activity, help in understanding biological terms, their content, memorizing them and increasing their ability to use them in practice. To test the effectiveness of the innovative method, we decided to compare it with the traditional method. We used the following types of innovative methods: technological integration, project-based learning, gamification, experience-based learning, differentiated learning, video and audio lessons, mobile applications. We trained Group B with these methods for 2 weeks, while Group A was taught only with traditional methods. In the traditional method, we lectured only on the topic, students explained what they understood and answered the question. When we taught Group B, we used a combination of innovative methods. For example, audio and video lessons, as well as gamification, were used to explain a lesson on "Ecological Pyramids." And for tasks related to the topic, mobile applications and project-based learning were used. In the topic "Study of the consistency of ecosystems in your region with the illumination of statistical methods of analysis" the method of learning based on experience was used.

1 Introduction

In general, the teaching of biology dates back to the end of the 19th and the beginning of the 20th century. Since the end of the 19th century, species classification and anatomy began to serve as the basis for the development of biological science. Lessons were based on lectures, textbooks, experiments and memorization of information. At the beginning and middle of the 20th century, microscopy and biochemistry, genetics were studied in depth, and new information was added to the textbook. But the teaching method has not changed from the traditional method. By the end of the 20th century, biological science was developing rapidly, new discoveries were made due to advances in technology, and the teaching method became more interactive and interesting. Biological science, like any other science, is constantly evolving, which requires constant updating of curriculums for different biological disciplines like genetics, bioinformatics and biotechnology and many others. Accordingly, there is a demand for engaging innovative teaching methods. Teaching methods should encourage the

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development of critical and logical thinking in students and correspond to modern level of science development. This was due to the development of scientific fields in the direction of natural sciences and the expansion of the field of education. When didactics began to develop, teaching methods included lectures, reading textbooks, seminars, inquiry-based lessons, and memorization of biological concepts and terms. As time developed, technology also developed, and accordingly, the teaching methodology underwent changes.

Multimedia resources, online platforms and interactive methods make the lesson easier for both teacher and student and provide additional information. Online platforms help teachers check simultaneously while students do their work, and interactive methods make it possible to work with multiple students at once. This is due to the fact that news in the field of biology has increased and led to an increase in practical work, and the development of technology has influenced the emergence of multimedia resources, computer modelling, the development of online platforms and interactive methods in biology teaching methods [1].

As our President K. K. Tokayev said: “Today, countries relying on advanced technologies, science and education achieve rapid development. In the new era, the quality of school education has a direct impact on the development of the state, and the quality of the school depends on the teacher. As we see, pedagogy has become one of the most important branches of science. Therefore, radically new approaches are needed in this area” [2, p. 1]. The way to increase the competitiveness of our country is to increase the efficiency and strength of the education system. To this end, in 2016, the content of textbooks was completely changed in the Republic of Kazakhstan, and accordingly, the principle of education changed from “teaching” to “instruct” [2]. In support of this statement, it can be said that the amount of independent work by students and the development of innovative methods have increased. The goal of our research work is to study the effectiveness of innovative methods of teaching biology. Students should not be limited in theory at the biology lessons. Innovative methods help students gain a deeper understanding of the topic, consolidate theoretical knowledge through experience, use it in practical life and increase interest in biology. Innovative methods continue to develop, but traditional methods cannot fully unleash students' abilities [3].

2 Materials and Methods

2.2 Participants and Teaching methods

Forty four volunteer 1st year students of al-Farabi Kazakh National University majoring in Biology were recruited as study participants. The average age of students was 19 years. We divided the students into groups A and B. A – control group (22 students), B – experimental group (22 students). In total, 6 lessons, 3 lectures and 3 seminars were held in each group. There were such topics as “Trophic levels”, “Types of relationships”, “Solving environmental problems and environmental situations”.

In the first week before the experiment, both groups had classes using the traditional method to assess the students' initial activity in the lesson. From the second week, the traditional method was used for control group to conduct the lesson, and innovative methods were used for the experimental group. Several types of innovative methods and traditional teaching systems have been used as methods for teaching biology.

Technology integration: The benefit of gadgets, interactive whiteboards and online platforms can be very useful in biology lessons for more detailed learning, obtaining additional information and improving feedback between students and teachers [4]. We used the method in every lesson, we did some tasks with the students using a mobile phone, and we showed different videos and experiments on the interactive whiteboard.

Project-based learning (PBL): PBL promotes students' independent work and ability to work in groups. At the same time, the quality of students' independent work improves when they use theoretical knowledge in practice and investigate for additional interesting information [5].

Gamification: Games make it easier for students to understand a subject. It creates healthy competition among students, helps them achieve their goals by completing levels and scoring points, and also refreshes their minds. This piques students' interest during the lesson [6].

Experiential learning: Experience is necessary for students to deepen their knowledge of specific topics and experience them for themselves. The student also needs to understand how a living organism works, how they are interconnected with nature, etc.

Differentiated learning. Differentiated learning consists of graded and creative tasks. In the differentiated teaching method, students are not divided into different levels; on the contrary, in order to avoid inconvenience among students, all students perform tasks at the same level and all students have the opportunity to demonstrate their abilities [7].

Video and Audio Lessons: These techniques are very useful for deepening knowledge of biology class topics, visualizing information, and better understanding complex concepts. Video and audio lessons help students gain more information, review and reinforce what they have learned by observing different experiences. Definitions and terms that are difficult to understand in a textbook can be easily understood by seeing and hearing them with your own eyes through audio and video lessons [8].

Mobile applications: Mobile applications have become an integral part of our daily lives, and can also become an excellent tool for schoolchildren to optimize their work. There are many apps that offer interactive activities, quizzes, and fun biology games. These applications can make the learning process interesting and exciting, and also help improve the efficiency of learning the material [9].

Traditional method: Educational institutions have been using this type of training for many years. The method is based on lectures, where students recite homework contents to students regarding limited topics [10].

2.2 Statistical analysis

For a comparative statistical analysis of the learning outcomes of the control and experimental groups, paired Student's t-test was used. Statistical analysis was carried out using the Statistical Package for the "Social Sciences (IBM SPSS, V.21)". Differences between groups were considered as significant at $p\text{-value} \leq 0.05$. Quantitative data are presented as mean \pm standard deviation (SD).

3 Results and Discussion

We started the research work by teaching 1st year students with the traditional teaching system. During the lesson, we evaluated the results based on the students' activity, attention and effectiveness of the method and for the experiment, we conducted a lesson on the topics of the chapter "Biosphere, ecosystem, population".

Firstly, we confirmed the progress of the students before the research. In each lesson, the maximum score attainable by students is 7 points, the medium academic progress is estimated at 5–6 points, and for the low level of training per lesson was estimated at 3–4 points. As mentioned above, in the first week before the experiment, both groups had classes using the traditional method to assess the students' initial activity in the lesson. Then we noticed that the activity of both groups was the same. From the second week, the traditional method was used for control group to conduct the lesson, and innovative methods were used for the experimental group. As we can see, the activity of the experimental group increased.

Presumably, innovative methods influenced their activity in the classroom. It was the mixing of different innovative methods that opened up students' interest in biology ($p < 0.005$) (Table 1).

Table 1. Indicator of students' academic progress (SAP) before and after practice

| Time of SAP assesment | Group | Average points | P-value |
|-----------------------|--------------------|----------------|---------|
| Before practice | Control group | 3,68±1,67 | 0,85 |
| | Experimental group | 3,59±1,53 | |
| After practice | Control group | 3,50±1,30 | 0,00 |
| | Experimental group | 5,77±1,11 | |

We checked the students' knowledge of the biology lesson through the primary test. The test consisted of 30 questions, 5 answer options, a score above 25 was considered good, and a score between 25 and 20 was considered average, and a score below 20 was considered low.

Table 2. The outcome of the control work that was conducted before and after implementing innovative teaching methods for biology for a two-week period.

| Testing time | Group | Average points | P-value |
|----------------|--------------------|----------------|---------|
| Primary test | Control group | 17,73±5,59 | 0,957 |
| | Experimental group | 17,64±5,43 | |
| Secondary test | Control group | 16,23±5,09 | 0,002 |
| | Experimental group | 21,55±5,45 | |

We trained group B for two weeks, mixing all of the above innovative methods. Both groups had the same topics in the lesson, from the chapter "Biosphere, ecosystem, population" and as a result, after 2 weeks, the final test was taken, and we observed how much the students' learning progress changed during this time. For group A the traditional educational system was used. During the lesson, we observed a decrease in students' interest and activity levels ($p < 0.005$) (Table 2).

4 Conclusion

As we can see, the DSL results of experimental group, which was taught using the innovative teaching system, increased, while it decreased in control group, which studied using the traditional teaching system. During the course of the lesson, the enthusiasm, activity and research of experimental group increased to a high level. Research on the effectiveness of innovative methods in teaching biology holds great promise for the advancement of biology education. The use of innovative methods in biology classes has given good results. The activity and level of knowledge on the topics covered in the experimental group increased significantly. As shown, innovative methods revealed different sides of students; they worked individually, in pairs and in groups. Different methods helped students develop their abilities and capabilities. Using innovative approaches, educators create a dynamic learning environment that sparks interest, fosters critical thinking, and prepares students for the challenges and opportunities of the biological sciences.

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