

IMPROVEMENT OF THE METHODOLOGY FOR TEACHING MENDEL'S LAWS BASED ON AN INNOVATIVE APPROACH

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ANNOTATION: This article highlights the issues of improving the process of teaching biology, in particular, Mendel's laws, based on an innovative approach. The study analyzes the influence of the use of modern pedagogical technologies on the quality of students' knowledge, analytical thinking, and the formation of scientific thinking. The article demonstrates the possibilities of conveying the essence of Mendel's laws to readers in an understandable, interesting, and practical way through interactive methods – “Insert”, “Cluster”, “Everyone can teach everyone” as well as using media education tools, virtual laboratories, and digital resources. The educational process, organized on the basis of an innovative approach, forms in students the skills of independent thinking, problem-solving, scientific analysis, and a creative approach. According to the research results, the use of innovative methods is an important factor in enriching the content of biology education, increasing students' interest in science, and educating them as creative individuals with modern competencies.

KEY WORDS: innovative approach, Mendel's laws, interactive methods, biology education, cognitive activity, media education, digital technologies.

INTRODUCTION

Today, the main requirement of the educational process is the formation of independent thinking, analysis, problem-solving, and a new perspective in the student. From this point of view, the application of innovative approaches and modern pedagogical technologies in biology education, in particular, in teaching the genetics section, is of particular importance. Genetics is one of the main disciplines in the study of human thought and scientific details, which forms a scientific worldview, causal relationships, and analytical thinking in students [2].

The laws of heredity, created by Gregor Mendel, are one of the most important discoveries in the history of biology and form the basis of modern genetics. One of the urgent directions of current educational reforms is to convey these laws to students in an understandable, analytical, and interactive form, and to increase their scientific interest.

Today, the process of digital transformation, the introduction of innovative methods, and the formation of a competency-based approach in students is accelerating in the education system of Uzbekistan. At the same time, it is observed that the teaching of genetics topics in many schools is still conducted on the basis of traditional methods. As a result, the level of students' deep understanding of the topic, the ability to model genetic processes, and the skills of scientific analysis are not sufficiently formed.

Therefore, an innovative approach to the process of teaching Mendel's laws, i.e., the introduction of interactive methods, virtual laboratories, media education tools, project-based learning, and elements of gamification, allows increasing the cognitive activity of students, conscious and interesting assimilation of the topic.

The application of innovative technologies transforms students from a passive listener to an active participant in the learning process. For example, such methods as “Insert”, “Everyone can teach everyone”, “Cluster”, “Analytical table” allow one to independently understand the essence of Mendel's laws, solve genetic problems, and analyze the results [3].

Also, the use of digital educational tools - virtual laboratories, 3D models, interactive animations -

makes abstract biological processes visual and strengthens interdisciplinary integration in students. This serves the full implementation of the “knowledge - practice – result” chain, which is the main principle of modern education.

From this point of view, improving the methodology of teaching Mendel's laws based on an innovative approach is not only an important factor in increasing the effectiveness of education, but also in forming scientific thinking, a research spirit in students, and preparing them for scientific activity at the next stage.

The relevance of this topic lies in the fact that it is aimed at updating the content of education by harmonizing the process of teaching biology with modern technologies, developing a competency-based approach, and solving the issues of forming the student's personality as an active, independent thinking subject.

As noted above, today the education system requires from the student not only the assimilation of ready-made knowledge, but also the skills of independent thinking, analysis, problem-solving, and a new approach. Therefore, the use of interactive and innovative methods in biology, especially in teaching Mendel's laws, has become a necessity.

In the traditional lesson format, Mendel's laws are often presented only orally. As a result, students memorize theoretical information, but cannot apply it in practical analysis or problem-solving. The use of innovative methods directs the lesson towards practice, turning the student not into a learner, but into a subject that creates knowledge [4].

In teaching Mendel's laws, it is important to develop students' skills in independent thinking, analyzing their knowledge, and connecting new information with existing knowledge. From this point of view, the “INSERT” (Interactive Noting System for Effective Reading and Thinking) method is an effective innovative method that serves to develop active reading, analysis, and thinking in students.

With the help of the “INSERT” method, the student transforms from a passive recipient of information into an active seeker of knowledge during the lesson. It also allows students to express their thoughts through symbols in the process of reading and learning new information, compare them with what they already know, identify innovations, and identify unclear or noteworthy points.

Applying this method to Mendel's laws allows students to formulate:

- in-depth analysis of the laws of heredity;
- independent understanding of the relationship between genotype and phenotype;
- analysis of the results of the experiment;
- to formulate their conclusions in a reasoned form.

The purpose of this method is to develop students' skills in analyzing text, distinguishing new and old knowledge, and identifying points of misunderstanding.

The application of the “INSERT” method in the lesson process occurs in several stages.

1. Preparatory stage.

The teacher distributes text about Mendel's laws (for example, about the first law).

Each student is explained the following system of symbols:

✓ - known information

⊕ - new information

? - made me think

- - i disagree with this or don't understand.

2. Educational stage. Students read the text and place the above symbols next to the text. The teacher observes them and records the students' opinions.

3. Analysis stage. Discuss each characteristic in groups. For example: "Why do the signs separate in a 3:1 ratio?" or "How did he prove this result?"

4. Final stage. Students present their conclusions in the form of a table. The teacher summarizes the Insert table and collectively identifies the main patterns.

Through this method, the student actively participates in the process of mastering the topic, developing

analytical thinking, asking questions, and drawing conclusions [5, 8].

In modern biology education, the use of interactive methods that encourage students to be active, think independently, and take an analytical approach occupies an important place. In this regard, the “Cluster” method is one of the effective methods that expands students' thinking, helps to determine the logical connection between concepts on the topic.

In teaching Mendel's laws, this method allows students to systematically study the basic concepts of the hereditary process (gene, allele, dominant, recessive, genotype, phenotype, segregation, combination, etc.). As a result, students envision genetic processes as a whole, visually express their knowledge, and develop the skills of mutual analysis.

The “Cluster” method (Eng. cluster – “group”, “set”) is a method of graphic organization based on grouping students' knowledge and thoughts around a certain central concept. It allows one to consider the educational material as a holistic system, identify interrelationships, and draw new conclusions.

This method is very effective in demonstrating cause-and-effect relationships between genetic concepts when studying Mendel's laws, as well as in developing students' independent thinking skills.

The application of the "Cluster" method in the lesson process occurs in several stages.

1. Preparatory stage.

The teacher announces the topic of the lesson: "Mendel's Laws." Students are asked to memorize and write down the basic concepts on this topic. The purpose of the lesson is to determine the essence of the laws of heredity, to understand the regularities of the transmission of genetic traits.

2. Definition of the central concept.

On the board or interactive slide, the word "Mendel's Laws" is written in the center. The teacher, together with the students, asks about the main ideas related to this central concept. For example:

Heredity: genes, alleles, dominant and recessive traits, the law of segregation, the law of independent combination.

3. Grouping ideas and creating a cluster. The concepts put forward by the students branch into the central environment, and each has its own small cluster.

For example:

Gene → Allele, Dominant, Recessive.

Heredity → Transmission from generation to generation, Hybridization, Traits.

Law of Separation → 3:1 ratio, Gametes.

Combination law → Independent separation, Phenotypic ratio

During this process, students explain their thoughts with justification, and the teacher guides their logical thinking.

4. Analysis and generalization.

Once the cluster is complete, students analyze the networks they created and summarize the essence of Mendel's laws.

For example, the reader concludes: "Mendel's laws are biological principles that express certain patterns of hereditary transmission of traits. Traits are passed down from generation to generation through genes, which exist in pairs - alleles."

After this, the teacher explains the cluster in a general form and comes to a final conclusion together with the students.

The "Cluster" method is an effective tool for systematizing knowledge in teaching Mendel's laws, understanding the relationship between basic concepts, and developing students' analytical thinking.

This method helps students:

- visual perception of the subject;
- logical analysis of genetic processes;
- working in a group and exchanging ideas;
- develops skills in drawing general conclusions.

As a result, students not only memorize Mendel's laws but also understand their scientific essence and

can apply them to real biological processes [6, 8].

Among modern pedagogical technologies, the “**Everyone can teach everyone**” method is an effective interactive method that allows students to deepen knowledge through mutual learning, exchange ideas, and mutual explanation.

The essence of this method is that each student acts not only as a student, but also as a teacher - that is, he explains, interprets, and expresses the acquired knowledge in his own words. In this process, the student understands the topic more deeply, analyzes it, and reinforces it with practical examples.

The method can be especially effective in the process of teaching Mendel's laws. Because this topic includes many concepts (gene, allele, dominant, recessive, heredity, phenotype, genotype, and others). In the process of mutual explanation of these concepts, students independently discover their interrelationship.

In addition, the "Everyone can teach everyone" method:

- turns students into active participants;
- develops a culture of teamwork and communication;
- reinforce knowledge by learning from each other;
- is based on the principle of peer pedagogy.

This method is a teaching method that allows students to become teachers and, having mastered certain knowledge, share it with their peers.

The purpose of this method is to provide students with the maximum amount of information necessary in the learning process, while simultaneously generating interest in obtaining and providing information. Also, a student who has received the volume of information conveys it to as many friends as possible over a certain period of time.

The application of the "Everyone can teach everyone" method in the lesson proceeds in several stages.

Students are divided into small groups. All group members are given handouts containing the same problem and the conditions for solving the problem are explained.

1-Handout. In cotton plants, the brown color of the fiber partially dominates over the white color. In F_1 hybrids, the fiber color is light brown. If F_1 hybrids are self-crossed, find the genotype and phenotype ratios of the cotton obtained in F_2 .

Step 1: Students who understand and solve the problem and present it to the teacher become the teacher's "assistants," that is, "junior teachers."

Step 2: For students experiencing difficulties in solving the problem, the teacher and assistants conduct individual explanatory work and solve the problem together.

Step 3: distribute second handouts to the students.

2 - Handout. In the pear plant, the red color of the flower (A) is completely dominant over the white color (a). If the F_1 hybrid is crossed again with a form with a recessive trait, what will be the result of F_2 segregation?

Step 1: In the process of solving the problem in the second handout, the number of "assistants" increases again.

Step 2: Assistants and the teacher conduct further individual explanatory work with students who are struggling to solve the second problem.

Step 3: distribute the third handout to the students.

3-Handout. By crossing light anthocyanin plants of cotton, 680 plants were obtained. Of these, 340 are light anthocyanin. How many of the remaining plants are green?

Step 1: In the process of solving the problem in the third handout, the number of "assistants" increases again.

Step 2: The assistants and the teacher will again conduct individual explanatory work with students who are struggling to solve the third problem.

Step 3: This action can be continued until the end of the lesson.

As a result, all students fully understand and master the topic.

The "Everyone teaches everyone" method covers all students during the lesson. Creates opportunities

for mastering the topic with the help of peers. As assistants “explain problem-solving methods to their peers” their acquired knowledge is further reinforced. Most importantly, although problem-solving is quite complex, it is easier to master in a friendly, mutually beneficial environment [7, 8].

In conclusion, it should be noted that improving the methodology of teaching Mendel's laws based on an innovative approach is one of the current directions of modern biology education. Because innovative pedagogical technologies introduce new methodological possibilities into the educational process and serve not only for the deep assimilation of genetic knowledge by students, but also for the development of analytical thinking, scientific logic, and problem-solving skills.

The use of interactive methods, digital technologies, media education tools, and project-based learning methods in the modern education system allows for the harmonization of the theoretical foundations of Mendel's laws with practical activity. This forms students as active subjects in the learning process and ensures their independence and creativity in the learning process.

In lessons organized on the basis of an innovative approach, students analyze their knowledge, connect it with existing experience, and develop scientific thinking by modeling genetic processes. As a result, in the process of teaching Mendel's laws, the cognitive, interactive, and practical components of learning are combined.

Thus, the introduction of innovative methods into the educational process is an effective factor in deepening the disclosure of Mendel's laws, increasing students' interest in science, educating them in the spirit of research, and forming modern competencies.

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