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IMPROVING THE METHODOLOGY OF TEACHING IN BIOLOGY CLASSES BY TAKING INTO ACCOUNT STUDENTS' INDIVIDUAL CHARACTERISTICS

Savutova Maloxat Erkinovna
Senior-Category Biology Teacher at School No. 1 in Urgench City

Abstract:
The growing heterogeneity of school classrooms requires teaching methodology to move beyond uniform content delivery toward flexible and diagnostically informed instruction. This need is especially visible in biology, where students differ in prior knowledge, pace of learning, scientific vocabulary, motivation, visual-spatial reasoning, and readiness for laboratory and inquiry-based tasks. The purpose of this thesis is to substantiate methodological approaches for improving teaching in biology classes by taking into account students' individual characteristics. The study is based on theoretical analysis and synthesis of contemporary research on differentiated instruction, personalized learning, student diversity, and biology education. The results show that effective methodology in biology depends on the integration of diagnostic assessment, differentiated content and tasks, multimodal explanation, scaffolded inquiry, formative feedback, and flexible use of digital tools. The study argues that attention to individual characteristics does not weaken common educational standards; on the contrary, it creates more equitable access to core biological concepts and scientific reasoning. The thesis concludes that improving biology teaching methodology requires a systemic didactic model in which the teacher coordinates goals, methods, resources, and assessment in relation to the learner's educational profile.

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Contemporary school education increasingly recognizes that students learn in different ways and under different conditions. OECD materials on personalising education note that one-size-fits-all approaches are insufficient for modern schooling, while UNESCO's recent work on technology in education emphasizes that adaptation and personalization are meaningful only when they remain human-centered and pedagogically justified. In this context, improving biology teaching methodology requires attention to the diversity of learners rather than reliance on a single instructional route for the whole class.

Biology is a particularly sensitive field for this issue because it combines observation, classification, experimentation, model-based reasoning, and explanation of invisible life processes. Research on students' views of biology learning shows that many learners struggle with topics such as hormones, respiration, genes, chromosomes, and cell division, and these difficulties are influenced not only by content complexity but also by teaching style, attitudes, motivation, and lack of meaningful resources. Therefore, the problem is not simply how to explain biology better in general, but how to organize teaching so that students with different cognitive and motivational profiles can meaningfully engage with the same scientific content.

The purpose of this thesis is to determine how the methodology of teaching biology can be improved by taking into account students' individual characteristics. The study is guided by the assumption that such characteristics should be treated not as obstacles, but as pedagogically significant variables that shape the design of explanation, practice, inquiry, and assessment.

This thesis uses a theoretical and analytical research design. The methodological basis consists of comparative analysis, interpretation, and synthesis of international policy documents and peer-reviewed studies related to differentiated instruction, biology learning difficulties, teacher preparation, and technology-supported biology education. A systematic review of differentiated instruction in secondary education was used as a conceptual foundation because it synthesizes the main forms of adapting content, process, product, learning environment, and time to student readiness, interests, and prior knowledge. Studies on biology teaching were then examined in order to identify which aspects of individual learner variation are most relevant in this subject area.

The analytical procedure focused on three dimensions. The first dimension concerned the nature of students' individual characteristics in biology classes, including prior knowledge, learning tempo, motivation, language ability, and readiness for inquiry. The second dimension concerned methodological responses, such as diagnostic assessment, differentiated tasks, scaffolding, and multimodal representation. The third dimension concerned the role of digital tools and virtual environments as supports for individualized learning. This approach made it possible to interpret improvement of biology teaching methodology as a coherent didactic process rather than as a collection of isolated techniques.

The analysis shows that the first condition for improving biology teaching methodology is diagnostic orientation. A teacher cannot meaningfully account for individual characteristics without identifying differences in conceptual understanding, misconceptions, reading ability, pace of task completion, and interest in biological topics. In biology, such diagnostics are important because many student difficulties are stable and topic-specific rather than accidental. When the teacher understands these differences at the start of a lesson or unit, methodological decisions become more precise and supportive.

A second result is that effective teaching in biology requires differentiated pathways to common learning goals. The same concept can be introduced through text, diagram, experiment, simulation, model, or real-life case, but students do not benefit equally from each format. Some require more visual support, some need step-by-step procedural guidance, and some learn best through problem solving or discussion. Recent research on technology-supported differentiated biology education shows that such approaches improve understanding, engagement, observation, and scientific explanation skills when the chosen tools correspond to instructional aims and learner needs.

A third result concerns inquiry and laboratory work. Biology education becomes more accessible when inquiry is scaffolded according to students' readiness. Virtual laboratory research indicates that digital and simulated environments can help learners grasp abstract topics, repeat procedures safely, and strengthen both conceptual understanding and laboratory-related skills. This is especially useful for students who need additional time, repeated demonstration, or visual reinforcement before moving to more independent practical work.

The findings suggest that improving methodology in biology classes requires a shift from uniform instruction to adaptive didactic design. This does not mean lowering requirements or fragmenting the curriculum. Rather, it means preserving common scientific goals while varying routes of access, forms of activity, and levels of support. Theoretical and empirical literature on differentiated instruction supports this interpretation by showing that adaptation is most effective when it is proactively planned and connected with assessment, feedback, and classroom organization. At the same time, teacher preparation remains crucial, because differentiated teaching demands strong subject knowledge, flexible planning, and the ability to interpret student diversity pedagogically.

For biology education, this discussion has a subject-specific meaning. Biological knowledge moves between the visible and the invisible, the concrete and the abstract, the observational and the explanatory. Because of this, methodology should support transitions between diagrams, verbal definitions, practical activities, models, and digital simulations. UNESCO's work reminds us that technology should serve pedagogy rather than dominate it. Thus, digital tools can strengthen individualized teaching only when they are integrated into a broader methodological system grounded in diagnosis, differentiation, feedback, and scientific coherence.

This thesis has shown that taking students' individual characteristics into account is a central condition for improving the methodology of teaching biology. The most effective methodological framework is one that combines diagnostic assessment, differentiated learning tasks, scaffolded inquiry, multimodal presentation of biological content, formative feedback, and pedagogically justified use of digital tools. Biology teaching becomes more effective when these elements are organized as a single didactic system responsive to student diversity. In this sense, methodological improvement is not merely a technical adjustment of lessons, but a reorientation of teaching toward equitable access to scientific understanding for every learner.

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