Original Research Article

Exploring innovative approaches to cultivating higher-order thinking skills in high school biology teaching from the perspective of interdisciplinary Integration

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Abstract: In the process of educational modernization,cultivating students'higher-order thinking skills has become a key objective of high school biology teaching.This paper,based on the perspective of interdisciplinary integration,analyzes its intrinsic connection with higher-order thinking skills,examines the current situation and problems of high school biology teaching,and then explores innovative approaches such as interdisciplinary knowledge integration,situational creation,project-based learning,and teacher training.The aim is to broaden students'thinking horizons,stimulate problem awareness,cultivate comprehensive abilities,and provide a beneficial reference for the reform of high school biology teaching and the overall development of students.

Keywords: Interdisciplinary integration; High school biology; Higher-order thinking skills; Innovative approaches

In today's era,technological innovation and social development demand higher standards for talent quality,with innovative talents possessing advanced thinking skills being increasingly favored.As a fundamental natural science course,high school biology bears the important responsibility of cultivating students'scientific literacy and comprehensive abilities.The concept of interdisciplinary integration breaks down the barriers between disciplines,injecting new vitality into high school biology teaching and opening up vast possibilities for the cultivation of advanced thinking skills.Exploring new paths for biology teaching within the interdisciplinary integration perspective and aiding the growth of students'advanced thinking has become an urgent issue for educators to address.

1.The connotation and relationship between interdisciplinary integration and higher-order thinking skills

(1) The connotation of interdisciplinary integration

Interdisciplinary integration is not merely a stacking of knowledge from different subjects but a deep integration of various knowledge systems,modes of thinking,and research methodologies.It breaks down traditional disciplinary boundaries,enabling students to establish a systematic and comprehensive knowledge network in the learning process to address complex and ever-changing real-world issues,such as the deep integration of biology and chemistry in the field of biochemistry,revealing the microscopic mysteries of life.

(2) The connotation of higher-order thinking skills

Higher-order thinking skills transcend the lower cognitive levels of mere memorization and understanding,encompassing critical thinking,creative thinking,problem-solving abilities,and metacognitive skills.In biology learning,this is reflected in students'ability to analyze the mechanisms behind biological phenomena,design experiments to explore,and evaluate the pros and cons of biotechnologies,demonstrating deep cognitive behaviors.

(3) The relationship between the two

Interdisciplinary integration provides diverse nourishment for the cultivation of higher-order thinking skills. On the one hand,the integration process introduces collisions of thinking from different disciplines,such as the aid of physical logic in understanding biological physical processes,sparking students'innovative inspiration;on the other hand,the demand for interdisciplinary problem-solving prompts students to employ higher-order thinking,enhancing their abilities through comprehensive analysis and weighing choices.The two complement each other,collaboratively promoting the growth of students.

2. Current situation and problems in cultivating higher-order thinking skills in high school biology teaching

(1) Traditional and single teaching methods

In the current educational environment,many classrooms still adopt traditional teaching models,with teachers'lectures dominating the classroom.This phenomenon of"spoon-feeding"teaching is common.Students are often in a passive state in the classroom,busy recording the teacher's explanations,and lack opportunities for independent thinking and inquiry.This teaching method limits the students'mental activity,making it difficult to elevate their thinking to a higher level,and they remain at the surface level of knowledge memorization.

(2) Strict subject boundaries

In the teaching of biology,teachers often focus on the knowledge system of their own subject,and the content of teaching is strictly limited to the scope of biology textbooks.Few teachers guide students to relate biological knowledge to other subjects such as physics,chemistry,and mathematics.This approach leads to students'limitations in their knowledge perspective.When faced with biological problems that require interdisciplinary knowledge to solve,students often find themselves at a loss,unable to effectively integrate knowledge from different subjects to seek solutions to problems.This situation largely hinders the development of students'higher-order thinking skills.

(3) One-sided and lagging evaluation system

The current evaluation system has obvious one-sidedness and lag.Specifically,the current evaluation methods mainly rely on exam scores to judge the merits of students,a practice that excessively emphasizes the examination of memory abilities for biological basic knowledge and concepts.However,this evaluation method ignores the performance and cultivation of students'higher-order abilities in problem-solving,experimental design,and thinking expansion.This single evaluation orientation leads both teachers and students to focus on test-taking skills,thus not having enough time and energy to pay attention to and cultivate students'higher-order thinking skills.

3. Innovative approaches to cultivating higher-order thinking skills in high school biology teaching from the perspective of interdisciplinary integration

(1) Integration of interdisciplinary knowledge to broaden the horizon of thinking

When discussing cellular respiration and its energy conversion mechanisms,we can draw on the laws of thermodynamics from physics,especially the principles of energy conservation and energy conversion efficiency,to help students understand the core of biological energy metabolism more profoundly.By viewing biological processes through the lens of physical principles,we can enhance students'interdisciplinary thinking skills.For example,by comparing the differences in energy release between aerobic and anaerobic respiration

and analyzing the reasons with the principles of energy conversion,we can deepen students'understanding.When learning about biological macromolecules such as nucleic acids and proteins,we can incorporate knowledge of chemical organic chemistry,analyzing the synthesis and hydrolysis mechanisms of biological macromolecules from the perspective of molecular structure and chemical bonds.For instance,during the study of DNA replication,by breaking and rebuilding chemical bonds,students can precisely grasp the details of the changes in living matter with the help of chemical knowledge,thereby strengthening their logical analysis skills.

Genetics is a typical example of the integration of biology and mathematics.By applying probability calculations,we can predict the segregation ratios of genetic traits and draw genetic maps to trace the paths of gene transmission.Using mathematical tools,we can quantify the laws of biological inheritance,which not only helps to cultivate students'mathematical reasoning skills but also enhances their precise thinking.For example,when analyzing the results of Mendel's pea hybridization experiments,by verifying genetic laws through mathematical calculations,students can gain a deeper understanding of the basic principles of genetics.

(2) Creating interdisciplinary situations to stimulate awareness of problems

Starting from everyday life with"healthy eating and balanced nutrition,"and integrating knowledge from biological nutrition,chemical food component analysis,and mathematical nutrition intake calculations,students are guided to think about the scientific aspects of dietary combinations.For example,designing a healthy weekly menu for a family,considering various academic elements,and stimulating students'innovative thinking to solve real-life problems.Focusing on cutting-edge scientific research in gene editing,creating interdisciplinary learning situations:from the principles of genetic manipulation in biology,to the technology of chemical synthesis of nucleic acid sequences,to ethical discussions on the boundaries of gene editing,prompting students to comprehensively examine scientific research issues,fostering critical thinking and a spirit of exploration. For example,organizing student discussions on the application prospects of CRISPR-Cas9 technology.When discussing the history of biological evolution,incorporating elements of historical evolution and philosophical speculation,such as exploring the background of Darwin's theory of evolution and its impact on contemporary social thought,allowing students to appreciate the development of biological ideas in the long river of history and culture,broadening their humanistic perspective,and stimulating deep thinking.

(3) Interdisciplinary project-based learning to cultivate comprehensive abilities

Combining the campus ecological environment,we initiated the"Campus Wetland Ecosystem Protection and Optimization"project,which includes interdisciplinary activities such as biological species surveys,geographical ecological niche analysis,and chemical water quality monitoring.The aim is to ignite students'passion for exploring nature.Students work in groups to plan task division,schedule progress,and research methods according to project goals.For example,the biology group is responsible for the inventory of animal and plant species,the geography group for mapping ecological distribution,and the chemistry group for testing the pH of water bodies,etc.Through these activities,students'abilities for overall planning and interdisciplinary cooperation are exercised.Each group conducts field investigations,sampling analysis,and data organization according to the plan. When problems arise,they will independently negotiate solutions,for example,when encountering difficulties in biological sample collection,they will cooperate with the geography group to choose suitable sampling locations,and the chemistry group will make the necessary tools,thereby effectively improving problem-solving and teamwork abilities.Project results will be displayed through reports,display boards,presentations,and other forms,with teachers and students participating together in evaluating scientificity,innovation,teamwork,and other

aspects,to promote students'reflection and growth,and strengthen their expression and self-evaluation abilities.

(4) Interdisciplinary teacher training to enhance teacher quality

The school regularly arranges biology teachers to participate in interdisciplinary training activities involving physics,chemistry,information technology,and other fields.Through inviting experts to give lectures and conducting workshops,teachers are helped to update their knowledge systems and improve interdisciplinary teaching skills,such as learning how to use bioinformatics to analyze biological big data.In addition,the school is committed to building an interdisciplinary teaching research team,promoting regular exchanges and cooperation between biology teachers and teachers of other disciplines,jointly designing interdisciplinary courses,solving teaching problems,and sharing teaching resources and experiences.For example,teachers have jointly developed the"Environmental Issues Inquiry"interdisciplinary course.Teachers have established the concept of lifelong learning,actively learning interdisciplinary knowledge,paying attention to the latest research trends,and incorporating these new knowledge into teaching,such as biology teachers self-learning artificial intelligence to assist in the design of biology experiments,adding new highlights to the teaching content.

4. Conclusion

The integration of disciplines sheds light on the cultivation of higher-order thinking in high school biology teaching.Through knowledge integration,the creation of scenarios,project-based learning,and the innovative paths of teacher training,it is possible to effectively break through teaching dilemmas and lay a solid foundation for the development of students'higher-order thinking abilities.However,this path of exploration is not achieved overnight and requires the collaborative and continuous efforts of educational departments,schools,and teachers. It is necessary to improve teaching facilities,optimize the evaluation system,and deepen teacher training to adapt to the trends of educational change and cultivate innovative talents with higher-order thinking,injecting vigorous momentum into social development.Future research can focus on precise quantification of integration effects and the exploration of new integration models,continuously expanding the boundaries of interdisciplinary integration and the cultivation of higher-order thinking.

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