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Research on the Path of Using the History of Science to Develop the Core Literacy of Students' Biology

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Abstract: *The history of biological sciences reveals the journey of scientists exploring life, which contains great educational value. Based on actual teaching cases, this study explores the teaching path of using the history of biological sciences to cultivate students' core literacy from the four dimensions of the core literacy of biology. The specific path includes: experiencing the concept construction process to form life concept literacy; perceiving the process of scientific inquiry and strengthening the consciousness of scientific thinking; focusing on scientific research methods and enhancing the ability of scientific inquiry; comprehending the spirit of the scientist and enhancing the awareness of social responsibility.*

Keywords: *High school biology, History of science, Core literacy of biology*

The "General High School Biology Curriculum Standards (2017 Edition)" states that "Science is a process of development. Learning the history of biological sciences enables students to follow the path of scientists exploring the biological world, understand the nature of science and the methods of scientific research, and learn from the dedication of scientists to science.[1] The history of science is the history of the discovery of objective laws and facts,[2] which not only includes the exploration process of life phenomena and the development process of related science, technology and methods in biology, but also includes the change of viewpoints and attitudes held by scientists in the study of life phenomena.[3] In high school biology teaching, teachers appropriately select relevant biological science history for teaching, which has a positive meaning for improving students' core literacy. Based on this, how to promote the core literacy of students' biology subject through high school biological science history teaching and realize the high-quality development of education is worthy of further attention and research.

1. Experience the concept construction process and form life concept literacy

The concept of life is an abstraction after explaining the observed life phenomena and their interrelationships or characteristics. It is an empirical view of people. It is a consciousness, concept and method of thinking that can understand or explain biological events and phenomena. [4]The formation of the concept of life requires the construction of concepts at all levels. The clear construction of the concept hierarchy is conducive to the formation of logical lines for students and promotes a deep understanding of knowledge. The teaching process of history of science pays attention to the evolution of concepts, which can help students understand the connotation, development and logical connection between concepts, and deepen students' understanding and cognition of concepts.

For example, in the DNA molecular structure model construction teaching, students have completed the construction of the polynucleotide chain model after reviewing basic knowledge such as the composition of DNA. Then the teacher guides the students to ask questions: What is the three-dimensional structure of DNA? At this time, the teacher presented the X-ray diffraction pattern of DNA taken by Wilkins and provided information: Watson and Crick proposed a double helix structure based on the X-ray crystal diffraction photos and data. After analyzing the data, the students collaborate to construct a plane structure model of double-stranded DNA. During the construction process, students have a new question: Are the bases randomly combined? What chemical bond is used to connect the two chains? Then the teacher provided information: In 1951, Chagaf found that in the DNA of different organisms, there are A=T and G=C, and scientists discovered that the pairing between A and T, and between G and C is through hydrogen bonds[2]. Then, the students further

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revised the model based on the data, and finally got a plane model of the DNA double helix structure. Finally, the teacher guides students to spiral the obtained plane model to the right to obtain a simulated three-dimensional model of the DNA double helix structure. In the above teaching process, teachers guide students to understand concepts in the order of "DNA composition, skeleton composition and arrangement, base pair arrangement, base complementary pairing principle, DNA double helix structure". And the teacher explained the function of storing genetic information from the sequence of bases. Such guidance enables students to gradually understand the unity of structure and function through independent learning and building physical models.

Learning with the history of science as the main line allows students to better grasp the content and connotation of concepts, deepen their understanding of the process and essence of scientific research, and then use these concepts to understand life phenomena and explore the laws of life.

2. Comprehend the process of scientific inquiry and strengthen the consciousness of scientific thinking

Scientific thinking refers to the habit and ability of using scientific thinking methods to understand things and solve problems with a rigorous and pragmatic attitude on the basis of respecting facts and evidence.[4] Scientific thinking is the ultimate goal of intellectual development and the core purpose of science education. [5]The history of biological sciences is the history of various manifestations of scientific thinking when scientists explore the mysteries of biology. It completely and truly reflects the actual working process of a scientist when a certain life science theory is formed and developed, and shows a set of methods and thinking for researching and solving problems.[6][7] Therefore, in teaching, teachers should guide students to deeply analyze the various links in the process of scientist's inquiry and pay attention to students' thinking training, which is essential to promote the development of students' thinking and the formation of scientific literacy.

For example, when studying several classic experiments in the process of auxin discovery, the teacher first guides students to analyze Darwin's experiment process and results, and guides students to summarize the steps of scientific inquiry. On this basis, students are guided to question: Is Darwin’s experiment a hypothesis or a fact? Do we need to further validate the experiment? Does Darwin's "impact factor" really exist? At this time, the teacher presented Jensen's experiment process, and students exchanged discussions and analyzed the results of the guessing experiment. Afterwards, the teacher asked: Jensen’s experiment is a supplement to Darwin’s experiment, which proves that the effect of coleoptile is a chemical substance. In addition, what other hypotheses need to be verified in Darwin's experiment? At this time, the teacher presented the Bayer experiment, and the students tried to explain after analyzing the experiment. Finally, the teacher further asked: Through the experiments of the three scientists, we have a basic understanding of the reasons behind the phototropism of plants. In what areas do you think we can continue to study? After the students think about it, the teacher presents the process of Winter's experiment and guides the students to analyze the process and results of Winter's experiment, and further guides the students to recall the experiments of the first three scientists and analyze the differences between the experiments. Through group cooperation and exchanges and teachers’ advice, students found that experiments by scientists such as Jason, Bayer, and Winter are just proofs of different aspects of the hypothesis proposed by Darwin. This whole process reflects the scientific thinking of hypothetical deduction.

Through the teaching of history of science, students understand that scientific inquiry is a process of continuous development, revision and improvement. It not only promotes the improvement of students' scientific inquiry ability, but also promotes the development of students' scientific thinking methods such as comparison and classification, induction and deduction, analysis and synthesis, criticism and questioning.

3. Focus on scientific research methods and enhance scientific inquiry capabilities

Scientific inquiry is the ability to discover biological problems in the real world, for a particular biological phenomena, ask questions, experiment design, program implementation and the ability to exchange and discussion of results were observed.[4] The history of biological science not only imparts scientific knowledge, but also permeates the creative thinking mode of scientists and scientific research methods [8], which is helpful for the cultivation of students' scientific inquiry ability. In the teaching process, teachers can infiltrate the scientific methods embodied in the history of science to students, so

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that students can design the experimental process along the thinking line of scientists in the process of cooperative exploration, thereby promoting the development of scientific thinking.

For example, when teaching the replication of DNA molecules, teachers guide students to experience the "hypothetical deduction" in the history of science in order to cultivate students' scientific thinking and implement the core literacy of biology. In the classroom, the teacher first guides the students to recall the implementation process of the hypothesis-deduction method in the exploration of Mendel's law of inheritance. Based on the students' understanding, the teacher presents the information: 62 years ago, people began to be interested in the way of DNA replication when people recognize the structure of DNA. At that time, there have been three speculations in the scientific community, namely semi-preserved copying, full-preserving copying, and diffuse copying. Then the teacher guides the students to think: Which of the above three speculations is the real way of copying DNA? Through thinking and communication, the students proposed three hypotheses and tried to analyze the experiment using deduction and reasoning thinking methods. Then the team members tried to design experiments to prove their conjectures through cooperation. Finally, the teacher guides the students to draw the designed experiment diagrams on paper according to their own reasoning process and organizes group members to analyze and discuss the results of the experiment, so as to strengthen rational thinking and students' ability to design experiments and test hypotheses. In the process of discussing and verifying DNA replication methods, students have improved their scientific inquiry ability based on in-depth understanding of the experimental process and personal experience of the ideas and methods of scientific research.

Through the study of the history of science, students imitated and experienced the methods used by scientists in scientific inquiry, and deeply understood the basic steps of scientific inquiry. In this process, students not only established a correct attitude towards scientific inquiry, but also improved their practical inquiry ability in the process of inquiry.

4. Comprehend the spirit of scientists and enhance the awareness of social responsibility

Social responsibility refers to the responsibility and ability to participate in the discussion of person al and social affairs, make rational explanations and judgments, and solve problems in production and l ife based on the understanding of biology. [4]The history of science is a high-quality resource for cultivating students' social responsibility literacy, Which includes the research process of scientists on biological sciences. It embodies the scientific attitude of scientists to respect facts, be brave to innovate, and dare to question, and scientists' spirit of dedicating themselves to science and benefiting mankind.

For example, in the science history teaching of "Mendel's Law of Inheritance", the teacher introduced: Before the law of inheritance was proposed, people basically agreed with the theory of "Mixed Inheritance". But Mendel was skeptical, and for nearly a decade he experimented hybridization with peas, eventually coming up with two major laws of genetics and becoming the "father of genetics." Then the teacher combined Mendel's exploration process to guide students to realize Mendel's spirit of not being fame and fortune, striving for progress, and devotion to science, thereby enhancing students' sense of social responsibility; When learning about the discovery process of secretin, the teacher introduced: The discovery of secretin has gone through more than half a century. During which many famous scientists have conducted inquiries, and finally Bayliss and Stalin who did not believe in authority discovered secretin through persistent research. Based on the inquiry process of Stalin and Bayliss, teachers guide students to discover that one of the important reasons for their success is that they have the spirit of bold questioning, exploration and innovation.

Scientists are important carriers of scientific knowledge and scientific spirit. The history of science is conducive to promoting students' awareness of social responsibility. By studying the history of science, students can comprehend the spirit of scientists contained in it, the hardships and rigorous scientific attitudes of scientists in researching problems, and the original research intentions of scientists and the mission of promoting the development of society.

5. Conclusion

The history of biological sciences contains great educational value. It not only promotes students' learning of scientific knowledge, but also promotes students to master scientific research methods, cultivate scientific thinking, and establish correct life concepts and social responsibilities in the process of scientific inquiry. In the future, teachers should further take core literacy as a foothold, continue to

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explore and implement ways to cultivate students' biological core literacy, and promote the improvement of the quality of education and teaching in our country.

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