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Skillfully Use of Model Construction in High School Biology Teaching to Cultivate Scientific Thinking

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Abstract: *The content of high school biology is relatively abstract, making it difficult for students to learn, which reduces their interest in learning.Using model teaching can turn abstract into concrete, stimulate students' interest, and cultivate students' thinking.This article mainly uses the method of constructing models, using conceptual models, mathematical models and physical models to cultivate students' scientific thinking, and further improve students' core literacy of biology.*

Keywords: *High school biology, Model construction, Scientific thinking*

The new round of curriculum reform proposes to focus on cultivating students' core literacy in biology, not only focusing on the mastery of students' knowledge, but also focusing on cultivating students' thinking and practical skills. The "Ordinary High School Biology Curriculum Standards (2017 Edition 2020 Revision)" (hereinafter referred to as the "New Curriculum Standards") puts forward: The core literacy of biology includes four aspects: life concept, scientific thinking, scientific inquiry and social responsibility. "Scientific thinking" refers to respecting facts and evidence, advocating a rigorous and pragmatic attitude towards knowledge, using scientific thinking methods to understand things and solving practical problems thinking habits and ability [1].

Biology course is not only to teach the basic knowledge of biology, but also to guide students to analyze natural phenomena and cooperate to explore the laws of nature[2]. Teachers need to pay more attention to the training and cultivation of students' thinking when teaching. Model construction is a commonly used teaching tool in high school biology. Model teaching can enhance students' interest in learning, improve their ability to learn independently, better cultivate students' thinking ability, and further help students understand the content of learning. However, in the actual teaching process, on the one hand, some teachers choose to instill knowledge directly for the sake of teaching progress, ignoring the cultivation of students' thinking ability; on the other hand, because some teachers have not fully grasped the application of model construction, which makes the teaching effect not ideal. Therefore, how to master the general process of model construction, correctly and effectively use the teaching method of model construction, and further cultivate students' scientific thinking has become one of the important research topics for the majority of educators.

1. The concept and classification of the model

1.1 Concept

Model is a simplified and general description of the object of understanding for a specific purpose. This description can be qualitative or quantitative. Some use concrete objects or other visualization means, while others are expressed in abstract forms [3]. Abstraction and concretization are its two main characteristics. Abstraction refers to abstracting the prototype based on the prototype to achieve a specific purpose, so as to simplify the complex prototype and construct a model that can reflect the essential characteristics of the prototype . Concretization refers to the concretization of abstract scientific concepts, hypotheses, and theories into a specific model, so as to further play the role of theory in guiding practice.

1.2 Classification

In the high school biology textbook of the People's Education Edition, the model is divided into three

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categories: conceptual model, mathematical model and physical model. The advantages and disadvantages of the three are different. Teachers can rationally arrange model construction according to different teaching contents. Especially for some content that is difficult for students to understand, teachers can use models to specify the content that is difficult to understand to help students understand, master and apply them proficiently.

2. Skillfully use model construction in high school biology teaching to cultivate scientific thinking

2.1 Construct a conceptual model and cultivate the ability to generalize

A conceptual model mainly refers to a model that connects some related nouns or processes in a specific form through text, graphics, symbols and other forms to express certain phenomena or laws [5]. Conceptual diagrams, flowcharts and schematic diagrams are the three commonly used methods.

The general steps to construct a conceptual model mainly include: ①Clear the connotation of the concept: Clear the connotation of each concept is the basis for constructing the conceptual model; ② Clarify the relationship between various concepts: use scientific thinking to analyze the main elements and relationships (subordination, juxtaposition, identity, or opposition, etc.) between various concepts, Through the connection between the new and the old knowledge, the knowledge involved in the concept is combed to form the vertical and horizontal connection between the concepts; ③Construct a preliminary conceptual model: Through the understanding of concepts, choose appropriate types such as conceptual diagrams, flowcharts or diagrams, and connect the concepts according to a certain logic; ④ Improve the conceptual model: In the process of further study and application, the conceptual model is further improved to form a clear, clear, concise and logical conceptual model; ⑤ Application model: Apply the constructed conceptual model to help students establish a clear and intuitive understanding of the knowledge they have learned, and better apply theoretical knowledge to practice.

Take "blood glucose balance regulation" as an example: First of all, we must clearly understand the concepts of blood sugar, insulin, glucagon, etc. Secondly, it is necessary to clarify how insulin and glucagon are produced, what is the relationship between the two, and what effect they play on blood sugar regulation. Third, choose the appropriate type of conceptual model and establish a preliminary conceptual model. This content is suitable to be summarized in a graphical and graphical way. Fourth, improve the conceptual model through further study. Finally, apply the conceptual model to solve the corresponding problems.

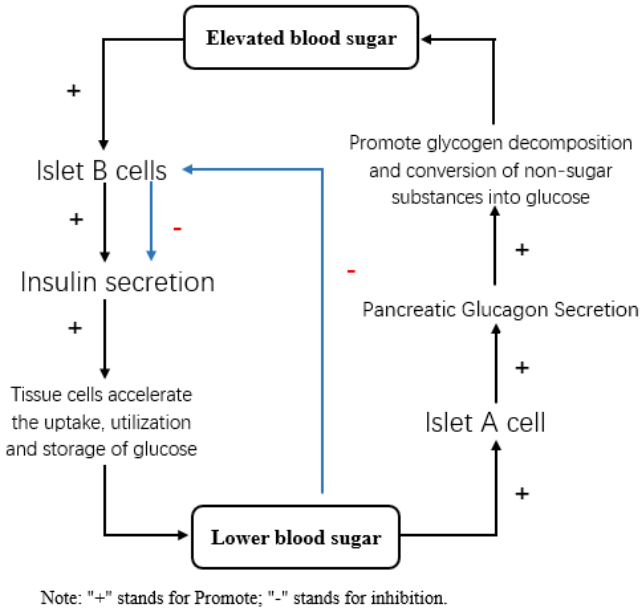

Figure 1: Diagram of blood glucose balance regulation mode

The construction of conceptual models can not only improve teachers' thinking ability, but also improve and develop students' thinking ability. Teachers can clarify the relationship between the various parts of the content by constructing a conceptual model according to the arrangement of teaching goals

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and content, combined with the high school biology curriculum philosophy and curriculum goals stipulated in the new curriculum standard, so as to clarify some important concepts or processes that are difficult to understand. Expressed in the form of conceptual diagrams or flowcharts, build a complete knowledge network system, and better convey the knowledge to students in a vivid, interesting and orderly manner. During the learning process, students can think about and summarize what they have learned, form a knowledge system by constructing a conceptual model, present complex and difficult content in a simple and intuitive way, and change the previous rote memorization method. Establish the connection between knowledge, further enhance its ability of generalization, and cultivate scientific thinking.

2.2 Construct a mathematical model and cultivate the ability of analogical reasoning

Mathematical models refer to teaching forms such as equations that can express mathematical relationships, properties, and graphs of applied mathematics between things [6]. There are two types of equation model and function model. Constructing a mathematical model realizes the cross-discipline of mathematics and biology. Through the application of mathematical thinking to solve biological problems, it can more clearly and intuitively understand the essence and laws of things.

The general steps of constructing a mathematical model mainly include: ① Observe the research object and ask questions. ②Propose reasonable assumptions. ③According to experimental data, use appropriate mathematical forms to express the nature of things, that is, establish mathematical models. ④ Check or revise the model through further experiments or observations. ⑤ Application of mathematical model [7].

Take the "J-shaped growth of the population" as an example: According to the problem of bacterial reproduction raised in the discussion of the problem, it is assumed that under the condition of no restriction on nutrition and living space, a certain type of bacteria will reproduce through division in 20 minutes. First, ask the question: Bacteria divide every 20 minutes. How to calculate the number of bacteria after n generations? Second, make assumptions: Under the condition that there are no restrictions on resources and living space, the growth of bacterial population will not be affected by the increase in population density; Third, build a mathematical model$N_n = 2^n$(N represents the number of bacteria, n represents the number of generations); Next,by observing and counting the number of bacteria, test or revise the model established by oneself [7]; Finally, apply the mathematical model to solve practical problems. The analysis shows that the growth of bacteria shows a "J"-shaped trend. Through analogy reasoning, the population will show a "J"-shaped growth under conditions such as abundant food and space conditions, suitable climate, and no natural enemies and other competing species. The mathematical model is: $N_t = N_0\lambda^t$(N0 is the initial number of the population, t is the time, Nt is the number of the population after t years, and λ is the multiple of the number of the previous year).

Constructing a mathematical model can realize the cross-discipline of biology and mathematics, which is in line with the concept of STEM education. Teachers guide students to construct mathematical models by means of inquiry-based teaching. Students can further improve their ability to discover, analyze and solve problems in the process of modeling. At the same time, the modeling process is also a process of group cooperation, which can enhance the team of students a sense of cooperation, to cultivate students' scientific thinking and innovative abilities.

2.3 Construct a physical model and cultivate spatial thinking ability

A physical model refers to a construction model that intuitively expresses the characteristics of a recognized object in the form of objects or pictures [3]. Different scholars have different classifications of physical models, among which the thought model and the physical model are the two commonly used types.

There are generally five steps to construct a physical model: ①Analyze the prototype, fully understand the characteristics of the prototype, and lay the foundation for the construction of the physical model; ②Prepare the materials and appliances needed for the construction of the physical model; ③ Establish the preliminary physical model; ④Revise and improve the physical model according to the prototype; ⑤Apply the construction Physical model.

Take "making a three-dimensional structure model of eukaryotic cells" as an example: First, learn about the structure of eukaryotic cells, understand the various organelles and cell structures inside

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eukaryotic cells, and determine the specifications of the model to be constructed. Second, prepare the materials and tools needed for modeling, such as paper, cardboard, rubber, Mud, thin threads, pins and other materials; Thirdly, the three-dimensional structure model of eukaryotic cells will be produced through group cooperation; Next, the preliminary constructed model will be evaluated, so as to revise and perfect the constructed physical model; Finally, the constructed model can be used to simplify the abstract content and solve practical problems better.

The physical model can make the abstract and difficult to understand more concrete. For example, "DNA double helix structure model", "dehydration condensation of amino acids", etc. By constructing a physical model, students can strengthen their spatial understanding of DNA double helix structure and amino acid structure, so as to better solve related calculation problems. The construction of physical model can effectively stimulate students' interest in learning, and enhance students' cooperative exploration and spatial thinking ability.

3. Conclusion

In the process of high school biology teaching, teachers use model construction reasonably and appropriately, which not only enables students to understand and master knowledge more intuitively, but also cultivates students' scientific thinking. For example, by constructing conceptual models to enhance students' ability of generalization; constructing mathematical models to cultivate analogical reasoning ability; constructing physical models to cultivate spatial thinking ability, etc. so that students can better apply theoretical knowledge to practice, and at the same time in the modeling process Cultivate students' sense of teamwork and innovation, and cultivate application-oriented talents.

References

[1] Ministry of Education of the People's Republic of China.(2018). General High School Biology Curriculum Standards (2017 Edition 2020 Revised). Beijing: People's Education Press, 1-5.
[2] Yin Haiyang. (2018).Analysis of Biological Model Construction Lessons——Take the "Special Topic on Biology Subject Model Construction" as an example. Biology Teaching in Middle School, {4}(Z1):142-144.
[3] Zhu Zhengwei, Zhao Zhanliang.(2019). General high school textbook: Biology: Compulsory 1 Molecule and Cell. Beijing. People's Education Press, 56-57.
[4] Zhou Ling, Li Qizhu.(2017). Teaching principles and implementation strategies for developing and using biological model resources to release students' potential. Biology Teaching in Middle School, {4}(21): 11-15.
[5] He Zhanquan. (2021).Thoughts on the construction of high school biology model based on core literacy teaching. Xue Zhoukan, {4}(04): 31-32.
[6] Hao Qilei, Yao Can.(2019). Research on high school biology model construction teaching based on core literacy. Teaching and Management, (12): 111-113.
[7] Zhu Zhengwei, Zhao Zhanliang.(2019). General high school textbook: Biology: Optional Compulsory 2 Biology and Environment. Beijing. People's Education Press,7-8.