Exploring the experimental teaching of high school biology based on the concept of life

--The experimental design of "Observing the mitosis of tissue cells in the root tip meristem" as an example

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Abstract: Under the new curriculum reform, teachers need to aim at cultivating students' core literacy in biology, focus on experimental teaching and cultivate students' awareness of life. This paper takes high school biology experiments as an entry point to analyze and summarize the current development of the concept of life and experimental teaching, and selects the experiment of "observing the mitosis of tissue cells in the root tip meristem zone" as an example of a classic experimental case to investigate how to implement biology experimental teaching in the concept of life. Through the reform of experimental teaching, students' emotional experience of learning biology is enhanced and a complete0good conception of life is constructed.

Keywords: concepts of life; high school biology; laboratory teaching; core literacy

1. Introduction

In the "General High School Biology Curriculum Standards (2017 Edition Revised 2020)", it is proposed that the teaching of the biology curriculum should be comprehensively elaborated in four aspects: life concepts, scientific thinking, scientific inquiry and social responsibility [1]. The concept of life is the most characteristic element in biology, and it is also the hallmark and key of core literacy in biology [2]. Biology laboratory teaching based on the concept of life enables students to deepen their perception of the natural laws of life and to experience the excitement of biology in a more rational and scientific way through manipulating experiments and experiencing the morphological structure and physiological functions of the organisms in the experiments under the guidance of teachers[3]. In some countries abroad, these concepts are classified as interdisciplinary. In the United States, the Next Generation Science Education Standards include interdisciplinary concepts such as "matter and energy, structure and function" [4]. With the increasing importance of core elements, the implementation of the concept of life into laboratory teaching is becoming more and more important, and laboratory teaching based on the concept of life has received worldwide attention and importance [5]. China's research in the concept of life started late compared to foreign countries, and by reviewing the literature, China has received much attention in the concept of life in the past five years. Under the leadership of curriculum standards, scholars have borrowed from and studied in depth in Western theoretical research, and have developed models, methods and strategies for studying students' conceptions of life at different levels in the context of national conditions. This paper analyses how to cultivate students' conceptions of life through secondary school biology laboratory teaching, optimizes the organization and implementation methods of secondary school biology laboratory teaching, and expects to provide suggestions for future secondary school biology laboratory classroom teaching through the study and analysis of excellent secondary school biology laboratory teaching cases.

2. Components of Life Concept Literacy

2.1 Structural and functional view

The concept of structure and function is an important part of the concept of life in the core literacy of biology. Most organisms have complex structures, and teachers convey to students through teaching the idea that structure and function are compatible and that the morphological structure of an organism determines its function in life activities. Experimental teaching of biology allows the cellular structure of organisms to be observed at a microscopic level so that the function of learning biological structures can be discovered and a more intuitive view of biological structure and function can be learned [6].

2.2 The matter and energy perspective

The normal functioning of the life mechanism is supported by the consumption of many substances and energy, and all life processes require constant consumption of energy to ensure the efficient functioning of the living system. At the microscopic level, matter is the carrier of energy and its consumption is the main means of obtaining energy. At the macro level, the ecosystem material cycle is the vehicle for the flow of energy. The two are interdependent and inseparable [7].

2.3 Evolutionary and adaptive views

Evolution and adaptation are part of the concept of life, one of the most biological concepts of life [8]. "Evolution" is Darwinian in origin, and is the growth, change and development of an organism over the years and generations, the evolution of its traits and genetic composition. "Adaptation is inextricably linked to evolution, and some scholars emphasise that adaptation is the mutation of an organism in a given environment and its consequent adaptation to that environment. Adaptation" can therefore be defined as the mutation and evolution of organisms to become more compatible with the external environment through natural selection under the influence of some external factors [9].

2.4 Homeostatic and equilibrium views

The concept of homeostasis and equilibrium is both an important part of the concept of life and an important biological idea for secondary school biology. All organisms live in a large environment, and in order to survive better in this environment, they have to maintain their own homeostasis and balance through their own regulation. Through certain regulatory mechanisms, the organism is kept stable so that it can better carry out a series of life activities such as growth, development and reproduction, and survive as a complete individual in a complex environment [10].

3. Experimental teaching of "Observing the mitosis of tissue cells in the root tip meristem

3.1 Analysis of teaching materials

The experiment "Observing mitosis in root apical meristem" is part of Chapter 6, Section 1 of Biology in the Hanyu version. It is a continuation of the knowledge of mitosis in cell proliferation, and is an experimental reproduction of the phenomenon of mitosis at a microscopic level after learning about the theory of mitosis. This lesson allows students to learn more about the structural features of mitosis at different stages of the process. As mitosis ensures the consistency of genetic information in both parental and zygotic cells, it promotes a deeper understanding of the nature of life at the microscopic level and effectively promotes the formation of a unified concept of life in terms of structure and function, matter and energy, evolution and adaptation, and homeostasis and equilibrium.

3.2 Teaching objectives

(1) Learn to culture onion root tips and make mitotic mounts of onion root tip cells to develop hands-on skills

(2) Observe the process of mitosis in plant cells, identify images of cells at different stages, and develop the ability to view, compare and analyse

(3) Draw a sketch of mitosis in plant cells and develop a scientific attitude of summarisation and rigour

(4) Recognise the importance of mitosis in cellular activity and develop an in-depth understanding of the nature of life

3.3 Key teaching points

Teaching focus: observing the process of mitosis in plant cells; drawing a sketch of mitosis in plant cells.

Difficulties: Recognition of images of cells at different stages in the process of mitosis in plant cells.

3.4 Teaching and learning process

Preparation for the lesson

Students will work in groups of 4 to investigate and select suitable vessels to culture onion root tips at a suitable temperature. The cultured onion root tips will be used as experimental materials for the class.

Design Intention: Students work together to develop a plan to cultivate onion root tips, with the experimental materials coming from the students' own cultivation. This process allows students to observe and participate in the whole process of plant rooting, to determine the appropriate temperature and humidity for the plant to grow, and to expand and review their knowledge about plants. They also increase their emotional involvement in this experiment and develop a concept of homeostasis and equilibrium in life.

Introduction to the experiment

The teacher leads students in a review of the theoretical knowledge of mitosis, including the morphological structure of chromosomes at different stages of mitosis.

Design intent: to solidify theoretical knowledge before the experiment, so that students can ensure the scientific rigour of the experiment only after they have clearly learnt the theoretical knowledge.

Experimentation

The teacher shows a pre-recorded video of the preparation of the mount and throws out the reflection questions, "What role does the mixture of hydrochloric acid and alcohol play in the dissociation?" "Why were the softened root tips rinsed in water?" "Why was the methyl violet or magenta acetate solution chosen for staining?" "Why are the root tips broken up?" Students can easily answer this by watching the video and reading the textbook.

After watching the video, groups work together to carry out experimental observations using their own cultured onion root tips, during which the teacher looks at each group's experiment separately from the lectern and provides assistance where appropriate. Once students have observed the distribution of chromosome morphology at different times in the cell, they can take photographs or make drawings to complete their record sheets.

Design intent: Using the video to guide students in their experimental operations eliminates the need to wait for the teacher to demonstrate the operation and provides more hands-on time for students; using a question and answer format for teacher-student interaction improves students' concentration in watching the video and guides them to focus on the key parts of the experiment; students' hands-on experiments improve their ability to operate the experiment and students observe the different periods of cell mitosis. At the same time, they can visualise the organelles associated with mitosis, think about the functions of these organelles in mitosis, and establish a concept of life in which structure and function are compatible.

Summarise the experiment and extend it

Display the group recording sheet and describe in words the characteristics of each period of the cell cycle and share what you have learned during the experiment.

The teacher summarises and sublimates the lesson with the analogous question, "The processes of photosynthesis and respiration studied earlier are accompanied by energy consumption, so is mitosis in cells energy-consuming?" Students learn by analogy that all cellular activities require energy consumption, and can quickly conclude that mitosis requires energy consumption. Finally, the teacher talks about the importance of mitosis for biological inheritance, as it maintains genetic stability between parent and offspring.

The teacher summarises the lesson, sublimates the significance of mitosis for living things and establishes the concepts of matter and energy and genetics and evolution of life.

3.5 Analysis and reflection on teaching and learning

Most traditional biology courses involve the teacher preparing the laboratory materials and the teacher demonstrating the process for the students. It is difficult for students to enter the laboratory and do the experiments themselves. In this lab lesson, from the preparation of the lab materials to the experimental operations, all are prepared by the students themselves, raising their awareness of independent inquiry learning. During the experiment, good questions are asked to help students determine the direction of their learning, and in the experiment, students are guided to independently construct and deeply understand the connotation of the concept of life and further understand the core literacy of biology. This lesson is demanding for the teacher, who needs to keep an eye on every step of the students' operations and intervene in time to provide guidance and ensure the smooth running of the experiment.

4. Conclusion

The concept of life is the starting point of biology laboratory teaching and is also the anchor point. Biology teachers can take the phenomenon of life or abstract biological knowledge as the starting point to design a biology laboratory lesson, explain the rich phenomenon of life through different experimental teaching methods, and help students gradually form a perfect concept of life in the process of experimental operation.

Biology experiments based on the concept of life can enable students to think about the meaning of each step in the experimental process, and to expand their thinking in a rational way.

The concept of life should be integrated throughout the teaching of biology, which is a long-term and gradual process. Not only in laboratory lessons, but also in the ordinary course of classroom teachers' teaching, the concept of life should always permeate. Experimental teaching of biology is one of the effective ways to develop students' concepts of life, and it has a positive impact on the development of life concepts. Through students' hands-on work, investigation of wonderful experimental phenomena and teachers' design of innovative experimental teaching methods, students are encouraged to take the initiative to learn and gain a deeper understanding of the connotation of the concept of life in biology.

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