

# The Cultivation of Top-Notch Innovative Talents in China Biology Olympiad and Its Strategies

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## ABSTRACT

China's cultivation of top-notch innovative talents in high school biology started relatively late, with few cases, and the main form is the existence of biology Olympiad. The cultivation of biology Olympiad in high school is characterized by extensive and advanced knowledge, independent learning, and open training. To improve the cultivation of high school biology Olympiad talents, the author believes that measures should be taken from the following aspects: 1. The education authorities should formulate corresponding policies to ensure students' learning environment. 2. Schools should promote the reform of teaching modes. 3. Elite schools should grasp the relationship between the Strong Foundation Plan and the cultivation of Olympiad Biology. 4. Adopt the Paul mode for teaching. 5. Form teams and cooperate in teaching with division of labor.

## KEYWORDS

High school; Biology Olympiad; Top-notch innovative talents; Paul model; Teaching

## 1 Introduction

Since the 21st century, emerging technologies such as the integration of artificial intelligence and medicine, as well as CRISPR gene editing, have been developing. Let people deeply understand the importance of bioscience to social health and future development. Amidst the rapid advancement of technology and international competition, top-tier innovative talents bear the significant responsibility of national revitalization, serving as a pivotal force in driving the modernization with Chinese characteristics and enhancing national competitiveness. The cultivation of top-notch innovative talents in biology is driven by both national strategic needs and cognitive development patterns. At the policy level, "China's Education Modernization 2035" proposes to establish a system for cultivating top-notch innovative talents, while the "General High School Biology Curriculum Standards (2017 Edition, Revised in 2020)" lists "scientific thinking" and "scientific inquiry" as core competencies of the subject. Therefore, it is imperative to cultivate top-notch innovative talents in biology for the new era. High school teaching needs to keep pace with the times, explore cultivation strategies that adapt to the development of high and new technologies, and implement the strategy of rejuvenating the country through science and education and strengthening the country through talents. The concept of "top-notch innovative talents" bears distinct Chinese characteristics. Clarifying the concept of top-notch innovative talents in high school biology education is conducive to following a talent development path that aligns with China's national conditions. In terms of the connotation and characteristics of "top-notch innovative talents", they need to possess solid professional knowledge, excellent innovative thinking, and broad awareness and vision. That is, in terms of knowledge structure, one should possess interdisciplinary knowledge and be able to integrate knowledge from different disciplines; in terms of thinking ability, one should possess an original spirit and innovation ability to question authority and shift thinking; in terms of awareness and vision, one should have a global perspective that faces the frontier. In other words, top-notch talents in high school biology need to achieve a dynamic and balanced understanding and integration of the big concepts and cutting-edge fields of biology. Based on this, by clarifying the concept of top-notch innovative talents in high school biology and drawing on the analysis of the current situation of cultivating such talents in China, as well as exploring and optimizing cultivation strategies, it is helpful to explore a development path that aligns with China's national conditions. The cultivation of top-notch innovative talents in China exhibits the following characteristics.

## 2 The Cultivation of Top-notch Innovative Talents in China Started Relatively Late and has not been Fully Explored

Since the 1960s, the United States has embarked on comprehensive educational reforms, with a particular emphasis on the study of innovative theories and the implementation of innovative education. It emphasizes highlighting students' individuality and fostering their ability to innovate independently. The "Biological Olympiad" system in the UK and the "Bio Valley Initiative" in Singapore have also achieved certain results. However, research on related concepts and training mechanisms in China started relatively late. After the introduction of concepts such as "multi-dimensional training" in 2005, attention was paid to the clarification and effect analysis of this model. However, current domestic research focuses more on "multidimensional teaching", which refers to an organic multidimensional structure composed of teaching methods, teaching techniques, teaching environments, and learning modes. Theories and application models explored from the perspective of teachers. However, research on how to cultivate top-notch innovative talents in biology from the perspective of schools has not been fully conducted. Coupled with its late start, from policy formulation to school

response, supporting policies and financial support are relatively weak.

### **3 The Cultivation of Top-Notch Innovative Talents Primarily Focuses on Higher Education, with Fewer Samples from Basic Education**

Literature review indicates that there is currently a wealth of exploration and application practice in the cultivation of top-notch innovative talents in higher education.

Firstly, students in higher education have ample time, which enables them to better exert their subjective initiative. Secondly, universities rely on various platforms to provide comprehensive resources and targeted guidance for talent cultivation. Thirdly, the specialization and subdivision of majors in higher education facilitate students' in-depth research and practice, and coupled with smooth integration with production practice, it promotes a large amount of theoretical and practical exploration.

Since 2015, the benefits of the college entrance examination based on the Olympiad Biology have become more abundant and diverse. More and more key high schools have begun to systematically cultivate Olympiad students, and an increasing number of gifted high school students have begun to participate in Olympiad training. Key high schools that organize students to participate in the Olympiad have specific training modes and carry out specific teaching activities for the Olympiad. Currently, for high school Olympiad students in China, Olympiad is not just an exam, but a layered selection process involving various competitions at all levels. Furthermore, in order to cope with the lengthy training process for selection, the Olympiad teaching activities in high schools have a profound impact on the growth and development of Olympiad students. The subject Olympiad is a typical gifted education activity, and it is also regarded as an important carrier for the early discovery, selection, and cultivation of top-notch innovative talents in the basic education stage.

However, domestic research has pointed out that high schools, driven by the utilitarian goal of further education, have adopted an alienated Olympiad training model. This is mainly manifested in the extreme arrangement of Olympiad teaching activities and teaching methods, which leads to students' bias towards certain subjects and depletion of their interests, hindering their overall development. Prolonged and intense mechanical training may also stifle students' curiosity, imagination, and creativity, and even affect their physical and mental health. This article aims to analyze the main characteristics, existing problems, and countermeasures of biology Olympiad teaching activities in high schools under the background of the new curriculum.

The main characteristics of current high school biology Olympiad teaching activities are as follows:

#### **3.1 The Knowledge Characteristic of "Being Extensive and Advanced"**

Compared to the knowledge system of ordinary college entrance examination courses, the characteristics of high school biology Olympiad teaching activities at the knowledge level are "large amount" and "ahead of time". Students need to learn almost all the professional content of undergraduate biology courses in college, and this knowledge is very ahead of time.

#### **3.2 "Autonomous" Learning Characteristics**

Due to the "advanced" knowledge characteristics of high school biology Olympiad teaching activities, most high school Olympiad coaches can only play a "guiding" role, and most knowledge relies on students' self-study. In this process, unlike the "spoon-feeding" of regular courses, when faced with a large amount of advanced new knowledge, they can actively ask various questions and then independently explore and solve them.

#### **3.3 "Open" Training Characteristics**

The openness of out-of-school training for high school biology Olympiad teaching activities is manifested in Olympiad students stepping out of the campus and integrating into an open learning environment. With the increasingly fierce competition in the Olympiad, out-of-school training has become an essential path for schools and students to grasp cutting-edge information, learn from peer experiences, and strengthen their own capabilities.

By engaging with society in advance, students experience more diverse interpersonal relationships than those on campus, broadening their horizons and increasing their knowledge. This helps them develop an inclusive attitude, enhance their ability to adapt to new environments, and become more open-minded in their personality.

### **4 Measures to Promote the High-Quality Development of teaching Activities for the Biology Olympiad in high schools**

#### **4.1 The Education Authorities Should Carefully Review the development Orientation of Academic Olympiad Competitions and Effectively Improve the policy environment for Further Studies Related to High School Biology Olympiad Teaching Activities**

The academic Olympiad is a special way to select and cultivate top-notch innovative reserve talents in specific disciplines in China and even internationally, playing a unique role in the examination and enrollment mechanism of colleges and universities in China.

However, the deep integration of academic Olympiad competitions with the examination and enrollment system has led to a phenomenon of "Olympiad fever among the general public". More and more key high schools and gifted students are being drawn into the Olympiad competition system, and even many irregularities have emerged, disrupting the normal teaching order and social fairness<sup>[1]</sup>.

In fact, academic Olympiads, which are dedicated to identifying and nurturing talents with exceptional gifts in specific disciplines, are inherently suited only for a minority of gifted students. In recent years, it has become necessary for education authorities to "cool down" academic Olympiads by raising the thresholds for direct admission and reduced-score enrollment based on Olympiad results, and by eliminating the bonus points awarded for participation in Olympiads.

Relevant departments should establish the concept of serving the national talent cultivation strategy and students' lifelong development, and properly examine the development orientation of the five major subject Olympiads. On the one hand, we must strengthen the management and supervision of the event, maintain its credibility and authority, and make the best of its strengths while avoiding its weaknesses. Fully leverage the role of Olympiad in the early identification and nurturing of top-tier innovative talents, providing a vast, stable, high-quality, and secure development platform for a select few gifted students with exceptional abilities; On the other hand, efforts should be made to change the awkward situation where Olympiad serves as a "single quantitative evaluation yardstick", and encourage the development of third-party educational evaluations. Promote diversified exploration of comprehensive evaluation, accelerate the establishment of an effective measurement and evaluation system for "comprehensive quality" of middle school students, guide high schools to establish a correct training model for Olympiad, and effectively improve the policy environment for further education in high school biology Olympiad teaching activities.

#### **4.2 Key High Schools should continuously Optimize the Training Mode for Olympiad Students and Accelerate the Reform of Biology Olympiad Education and Teaching**

Since the launch of the new round of college entrance examination reform in 2014, for high schools that conduct Olympiad teaching activities, national-level Olympiad awards are not only regarded as a demonstration of their educational strength, it is also regarded as a competitive advantage that can be obtained through independent selection at elite universities, and even some high schools that have never conducted Olympiad teaching activities have had to be drawn into the Olympiad competition system. Under the policy environment of the "Strengthening Basic Education Plan", key high schools with certain Olympiad strength still have sufficient motivation to continue or even strengthen their efforts in Olympiad training. Gifted high school students, who are under the pressure of academic competition, may still regard participating in Olympiad training as an important factor in gaining admission to elite universities. Currently, most high schools that carry out Olympiad teaching activities, driven by the utilitarian goal of further education, have positioned Olympiad as a way to leverage policy advantages to gain admission to elite universities. They tend to adopt a distorted Olympiad training model, which is not conducive to the early cultivation of top-notch innovative talents. Teachers of biology Olympiad should attach importance to stimulating students' subjective initiative, giving them sufficient autonomy, and encouraging them to learn independently and explore freely; Students should be guided to abandon the "sea of exercises" tactic, and encouraged to practice flexibly, draw inferences about other cases from one instance, and understand by analogy, so as to avoid damaging their enthusiasm through overtraining and falling into paradigm traps; We should persist in leading Olympiad students to participate in high-quality external training and learning. For gifted students who have surplus learning capacity and are willing to participate in Olympiad training, high schools should coordinate and plan curriculum settings and teaching arrangements, balancing college entrance examination and Olympiad, and taking responsibility for the comprehensive and long-term development of students.

Elite universities should rationally understand the relationship between academic Olympiads and the "Strengthening Basic Disciplines Plan", and lead the development of high school biology Olympiad teaching activities through the scientific selection and cultivation of top-notch innovative talents in basic disciplines. The "Strengthening Basic Disciplines Plan" highlights the supporting and leading role of basic disciplines, and many majors under this plan can be almost directly matched with the five Olympiad disciplines. Based on the implementation in 2020 and 2021, Olympiad silver medalists and above can be exceptionally selected for the "Basic Competence Development Program" of top-tier universities, and they can enjoy score recognition benefits in the strong foundation school tests. High-quality Olympiad students are still the favored targets of elite universities, Students who excel in academic Olympiads constitute a significant source of enrollment for elite universities' foundational majors. Compared to the era of "independent enrollment", the introduction of the "Foundational Plan" has further raised the threshold for entering top-tier universities through academic Olympiads, it is conducive to cooling down the "Olympiad fever" and ensuring that truly talented and interested top-notch innovative talents can stand out. It is a very timely policy adjustment. On the other hand, further research should be conducted to clarify the selection criteria for exceptional talents under the "Strengthening Basic Disciplines Plan", innovate selection mechanisms, improve selection methods, and focus on screening high school Olympiad students who are interest-driven, balanced in development, loyal to basic disciplines, and have potential for scientific and technological innovation. The scientific selection and cultivation of top-notch innovative talents in basic disciplines should lead the high-quality development of high school biology Olympiad teaching activities<sup>[2]</sup>.

## 5 Adopt the Paul Model

Renmin University of China High School has invited Dr. Paul Cammer, the head of the biology department at the renowned Thomas Jefferson High School for Science and Technology in the United States, as a consultant to guide the school's teaching reform. In terms of classroom layout, the seats are arranged in a rectangular or U-shape, with the teacher's position in the middle, and a chair that can be rotated freely is set up for the teacher. Students sit around the teacher, and the teacher can slide to any student at any time for face-to-face communication.

Under the "Paul model", how do teachers conduct their lessons? Taking biology as an example, each lesson is scheduled to last two periods, totaling 90 minutes. The teaching process is divided into several stages: preview assessment, new lesson introduction, and in-depth discussion. In the preview stage, small tests and student peer assessment are used to check students' self-study progress. In the new lesson introduction stage, questions are asked and explanations are provided, and the subsequent guidance can better help students understand the corresponding knowledge. The in-depth discussion stage can build upon the previous two stages for more in-depth exploration.

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In the establishment of a team for cultivating biological innovation talents, a team collaboration system is adopted to carry out biological competition teaching. Teachers work together to form a three-round mechanism for cultivating biological innovation talents - "the first round is laying the foundation, the second round is improvement and expansion, and the third round is sprinting to answer questions and address shortcomings", providing a solid guarantee for the cultivation of innovative talents. In the establishment of a team for cultivating biological innovation talents, a team collaboration system is adopted to carry out biological competition teaching. Teachers work together to form a three-round mechanism for cultivating biological innovation talents - "the first round is laying the foundation, the second round is improvement and expansion, and the third round is sprinting to answer questions and address shortcomings", providing a solid guarantee for the cultivation of innovative talents. Implement a teaching model that combines high school compulsory courses with advanced college preparatory courses. Fully tap into students' innate talents and potential, and strive to cultivate their learning, practical, and innovative abilities, laying the foundation for the selection and cultivation of talents with solid fundamentals in universities.

Implement modular teaching, and conduct high school biology compulsory courses, elective courses, and experimental courses in separate modules; attach importance to the practical nature of biology, Implement modular teaching, and conduct high school biology compulsory courses, elective courses, and experimental courses in separate modules; attach importance to the practical nature of biology, Promote the integration of teaching and experimentation, meet the personalized, diversified, and multi-level experimental exploration needs of students across different educational stages, and enhance the cultivation of students' abilities in practical operation and grasping the frontier development direction of biology; In addition, platforms such as colleges, universities, and research institutes can be leveraged to cultivate students' innovative practice, logical thinking, team collaboration, and interpersonal communication skills, providing a solid foundation throughout the process for nurturing high-quality, innovative, and versatile top talents. We advocate for teachers to integrate scientific research with teaching, fostering mutual enhancement between teaching and learning. We encourage the exploration and application of innovative teaching methods, such as the "5E" teaching model. Simultaneously, we actively recruit young teachers to inject fresh ideas and vitality into the teaching team, promoting the continuous development of the teaching faculty.

The theory of top-notch innovative talents is an important component of educational theory development. This article aims to advance the theoretical perfection of top-notch innovative talent cultivation in biology through research and collation, and enrich practical experience, Provide schools, teachers, and students with more distinctive and targeted new training methods and paths, enabling more comprehensive and effective work. The top-tier innovative talents in high school biology are focused on the field of biology Olympiad. The multi-dimensional collaborative cultivation of biology Olympiad runs through different educational methods and teaching levels, and has a strong practical guiding significance for schools to further study the cultivation of innovative talents and promote institutional development, It is beneficial in promoting the professional development of teachers, assisting them in solving challenges encountered in teaching practice, and fostering a meticulous and rigorous academic research atmosphere.

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