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Reform and Practice of the Experimental Course "Developmental Biology" under the Background of "Double First-Class" University Construction

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Abstract: University education is an important cornerstone of national development and social progress. Our university, a national key university with strengths in forestry disciplines, has been approved by the State Council as a "Double First-Class" construction university. To cultivate top-notch innovative talents in biology, high-quality teaching reform is urgently needed. Developmental Biology is a core course for the biological science major at our university. However, due to its high difficulty, strong interdisciplinary nature, and short establishment time, there are many teaching pain points, especially in the experimental course, such as outdated knowledge systems and unreasonable teaching design. These issues significantly hinder the achievement of the university's talent cultivation goals. Therefore, it is imperative to adapt to the new talent cultivation model, reform the curriculum system, teaching content, and teaching methods, and put these reforms into practice. Through such course reforms, we aim to improve teaching effectiveness and talent cultivation quality to meet the requirements of "Double First-Class" university construction.

Keywords: "Double First-Class" universities; Talent cultivation; Developmental Biology experiments; Teaching pain points; Reform and practice

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1. Introduction

National development and national rejuvenation rely on talents of various types, and institutions of higher education are undoubtedly important bases for talent cultivation [1]. To better cultivate talents, the State Council issued the Overall Plan for Promoting the Construction of World-Class Universities and First-Class Disciplines in 2015, after which universities across the country actively participated in "Double First-Class" construction [2,3]. The "Double First-Class" initiative includes elements such as first-class talents, first-class disciplines, and first-class majors, among which the cultivation of first-class talents is the core [4,5]. How to cultivate and gather top-notch talents, lead the development of China's science and technology, and provide strong support for building a world scientific and technological power is a key issue that current universities urgently need to solve [6,7].

Northeast Forestry University is an institution of higher education with coordinated development of multiple disciplines, featuring strengths in forestry and characteristics in forestry engineering. In September 2017, it was approved by the State Council as a "Double First-Class" construction university. In February 2022, it was selected for the second round of the national "Double First-Class" construction universities. The university currently has over 30,000 students, including 19,691 undergraduates. The rapid expansion of student numbers has forced the university to reposition its talent cultivation goals, comprehensively consider the student management system, focus on the all-round and comprehensive cultivation of undergraduates and postgraduates, and continuously explore the construction of a new talent cultivation model that meets the needs of "Double First-Class" universities. Consequently, teachers are required to adapt to this model, continuously reform the curriculum system, teaching objectives, teaching content, and teaching methods, and put these reforms into practice [8].

2. Teaching pain points in the experimental course of developmental biology

Developmental biology, an emerging interdisciplinary subject developed in the mid-20th century, integrates physiology, immunology, and evolutionary biology based on embryology, cell biology, genetics, biochemistry, and molecular biology [9,10]. As one of the most dynamic disciplines in life sciences today, it primarily teaches developmental events in multicellular organisms, including gametogenesis, fertilization, cleavage, embryonic development, organogenesis, growth, aging, and death [11]. It serves as a core course for the national first-class biology program and the elite talent class in the College of Life Sciences at our university. However, as an interdisciplinary field with a relatively short history, developmental biology is constantly enriched by innovative achievements, resulting in an evolving disciplinary framework and knowledge system that poses significant teaching challenges [12]. In particular, experimental teaching has developed slowly due to limitations in experimental materials and equipment, affecting the quality of training elite talents at our university, a double first-class university in forestry. Currently, the experimental course of developmental biology faces the following key teaching pain points.

2.1. Lack of innovation in experimental content and an inadequate curriculum system

Although several teaching reforms have been carried out in developmental biology, they mainly focus on theoretical courses. The content of experimental courses still follows the original design. Moreover, there is no universal experimental textbook for developmental biology in China, and the design of experimental content mainly relies on the research of teaching faculty, making it difficult to cover all the theoretical content of developmental biology. For undergraduate-level experiments, there is an overemphasis on confirmatory and basic experiments, where processes and results are often predetermined. Students merely repeat operations according to steps, serving only to verify and consolidate theoretical knowledge. Additionally, the experimental curriculum system has narrow coverage, relies on a single model organism, and suffers from insufficient in-class teaching time. These issues hinder students' enthusiasm and innovation, impeding the healthy development of the integrated undergraduate-graduate training model for innovative talents.

2.2. Lack of novelty in teaching design and unreasonable implementation

The integrated undergraduate-graduate curriculum system, aimed at cultivating innovative talents, requires teachers to adopt diverse teaching methods to stimulate students' enthusiasm. With the rapid development

of modern science and technology, information technology based on mobile phones or computers has been deeply integrated into college students' study and life. The popularity of the Internet enables students to access knowledge more easily and makes them more reliant on these electronic devices. Therefore, traditional experimental teaching methods need to keep pace with the times by incorporating multimedia tools such as MOOCs, micro-lectures, and virtual simulations to enrich teaching approaches.

2.3. Insufficient integration of ideological and political education, and inadequate stimulation of students' enthusiasm

In building an integrated undergraduate-graduate talent training model, ideological and political education in courses is a top priority. According to the requirements of the Ministry of Education, the experimental course of developmental biology still lacks sufficient ideological and political content. It fails to elevate curriculum-based ideological and political education to an overall and holistic level, lacking coherence and organic connection. Thus, active exploration and reform are needed to integrate ideological and political elements into experimental teaching subtly and naturally.

2.4. Singular course evaluation methods, detrimental to comprehensive ability cultivation

Course evaluation methods guide students' learning and affect their enthusiasm. In the past, the experimental courses at our university mainly adopted an evaluation model of "prioritizing experimental report scores and supplementing with daily performance." This model is often confined to formalistic aspects such as report writing, completeness of results, and attendance, failing to comprehensively assess students' entire experimental operation process. This is unfavorable for the comprehensive cultivation of students' abilities and the formation of innovative thinking.

3. Reform and practice of the experimental course in developmental biology

3.1. Reshaping teaching content to meet the requirements of integrated undergraduate and postgraduate cultivation

Since the launch of this course, the developmental biology course at our university has gone through the initial construction stage and the mature development stage. In the initial construction stage, the practical teaching content of developmental biology mainly relied on the research content of the teaching faculty, focusing on confirmatory experiments and basic experiments. In the mature development stage, although comprehensive experiments were added, the course still used mice as the sole experimental material, resulting in a relatively single application of model organisms. Through this reform, experiments related to the developmental processes of the classic model organism Caenorhabditis elegans and chicken embryos, as well as the expression of key genes, have been added, along with experiments involving zebrafish. Among these, Caenorhabditis elegans has a simple structure, is transparent throughout, has a short life cycle, is easy to cultivate, and has strong genetic operability. Chicken embryos are easy to incubate and observe, and gene expression during their development can be conveniently manipulated by students using techniques such as in situ hybridization. Since zebrafish rearing requires specialized equipment and relatively high investment, online resources have been introduced, and virtual simulation courses are used for teaching.

By updating the experimental teaching content, students can master the theories and scientific research methods of developmental biology, fully reflecting the advanced nature, innovativeness, and challenging nature of

the course. A curriculum system covering experimental content from gametogenesis to organ formation has been constructed. In the teaching process, research cases and cutting-edge advancements are integrated to achieve the three characteristics of the course: comprehensiveness, frontier nature, and advanced nature. The previous basic experiments have been reformed into comprehensive experiments, design-oriented experiments, and innovative experiments. While consolidating students' mastery of basic knowledge, emphasis is placed on integrating it with research progress to improve the overall level of the experimental course. Design-oriented experiments focus on student-centered approaches, giving initiative to students, exploring active learning methods, and using modern information technology and online experimental teaching resources to develop blended teaching methods, which effectively extend students' after-class learning time and enhance learning outcomes. Innovative experiments are integrated with students' undergraduate innovation projects. Teaching laboratories are fully open, and teachers' research content is incorporated to guide students in designing innovative experiments. Students are encouraged to further apply for undergraduate innovation projects based on their personal interests, participate in various academic competitions, and comprehensively improve their scientific research literacy and abilities, laying a solid foundation for a smooth transition to the postgraduate stage.

3.2. Advanced teaching design improves classroom teaching effectiveness

With the continuous expansion of postgraduate enrollment in colleges and universities, and the annual increase in the number of undergraduate graduates directly pursuing master's and doctoral degrees, it is required that more emphasis should be placed on the cultivation of comprehensive abilities at the undergraduate stage. This is crucial to promote the effective connection between undergraduate and postgraduate studies and achieve continuous improvement. Therefore, the rationality and effective implementation of undergraduate curriculum design are of great importance, which is also the focus of teaching reform in our university.

The reform of experimental teaching in developmental biology makes full use of the Internet, multimedia, and other means, and takes advantage of students' fragmented time to redesign teaching. It combines online platform teaching with traditional classroom teaching modes, utilizes online course resources, and intersperses micro-lectures to transform the traditional teaching model. In practical teaching, problem-based and heuristic teaching methods are adopted, along with flipped classrooms, split classrooms, teacher-student Q&A, and student mutual Q&A, to promote innovative thinking. Through independent experiment design and analysis, students' knowledge and abilities are both improved.

The curriculum design and implementation process is as follows:

(1) Before class: Questions are set online on the Chaoxing learning platform to arouse students' interest, and students are reminded to preview the courseware and key videos of experimental operations online.

(2) During class: Students are organized to actively discuss in combination with the teaching content, design experimental processes, question and debate, interact and communicate, take intelligent tests, receive instant feedback, conduct collaborative exploration, and summarize. Ideological and political elements are subtly integrated to guide students to establish correct outlooks on life and values.

(3) After class: Assign experimental result analysis, self-evaluation and mutual evaluation, expand research-based learning, and conduct summary and evaluation.

Through individual self-study, student-student discussion, teacher-student research, and mutual evaluation and joint appreciation, the reversal of teaching and learning, in-class and after-class learning, teacher-student roles, and knowledge conclusions and formation processes is realized. The online platform provides convenient channels for students' independent learning, topic discussions, and homework submission. The open teaching

laboratories encourage students to independently design innovative experiments, enabling them to enter a research state in advance and improve their research literacy.

3.3. Exploring ideological and political elements to stimulate intrinsic learning motivation

The Ministry of Education pointed out in the Guidelines for the Construction of Ideological and Political Education in Higher Education Courses that colleges and universities should, based on the professional characteristics and advantages of courses in different disciplines, formulate targeted key points for the construction of ideological and political education in each type of course, explore ideological and political elements in courses, and organically integrate them into course teaching in accordance with three course types: public basic courses, professional education courses, and practical courses [13]. Therefore, practical courses also need to explore ideological and political elements to stimulate students' intrinsic learning motivation and establish a correct outlook on life and values [14].

Through curriculum reform, the scientific research deeds of academic role models are integrated into the entire process of experimental course implementation, enabling students to perceive the scientific research spirit of seeking truth from facts and bravely climbing academic peaks, enhancing their confidence in scientific research. At the same time, by explaining the contingency and inevitability behind the "flashpoints" of original innovation, students' enthusiasm and interest in scientific research are stimulated [15]. For example, in the teaching of principles in the experimental course on oogenesis, contents such as the origin of human life and the evolutionary history of the Chinese nation can be introduced to arouse students' patriotic feelings and national pride. In experiments on embryo collection and transplantation, contents related to animal ethics and protection are added to guide students to correctly handle the relationship between scientific research and ethical values, explore ethical issues brought by technologies such as gene editing and human cloning, and encourage students to discuss these issues from social, cultural, and legal perspectives, thereby enhancing their awareness of abiding by laws and regulations. When students hesitate in the face of difficulties during experimental operations, the research cases of scientist Mr. Tong Dizhou can be told to help students understand the rigorous academic attitude and scientific spirit, and inspire them to study diligently and have the courage to be pioneers. Through such subtle and all-round ideological and political education, students can establish correct values, enhance their sense of social responsibility, and stimulate their intrinsic learning motivation.

3.4. Multi-dimensional evaluation system to promote students' all-round development

Under the integrated training system of research and education, the reform of experimental courses requires that assessment should not only evaluate students' mastery of basic knowledge, but also emphasize the improvement of their comprehensive abilities, such as cultivating their ability of critical thinking and analysis, independent problem-solving ability, and innovation ability, and stimulate students' intrinsic desire for knowledge and exploration through assessment. Therefore, the original assessment method of combining experimental attendance rate and experimental reports has been transformed into a dual evaluation system consisting of result-oriented assessment and open assessment. Result-oriented assessment includes experimental preview, experimental operation, experimental reports, and experimental scores; open assessment includes experimental design, cooperative reporting, innovative training, and simulation practice. Through multi-faceted and all-round assessment methods, students' learning motivation is promoted, the teaching effect is better grasped, and while improving learning ability and professional literacy, students' learning enthusiasm is stimulated, forming a good dynamic cycle.

4. Effectiveness of the reform in developmental biology experiment courses

Since the comprehensive development of the integrated undergraduate-postgraduate curriculum, the quality of talent cultivation has been significantly improved. Students participating in the curriculum reform generally report that the content and design of the experiment courses have strengthened their mastery of basic knowledge, significantly enhanced their experimental operation skills, and fostered their scientific research literacy, laying a solid foundation for their further engagement in scientific research during the postgraduate stage. After the implementation of the teaching reform, approximately 90% of undergraduates have participated in scientific research and innovation activities, and the postgraduate entrance examination rate has reached around 61%. Achievements such as "Top Student Classes", "Academic Excellence Dormitories", and students' innovative outcomes have been repeatedly reported by China News Network and People's Network, exerting extensive influence among universities both at home and abroad.

5. Conclusion

In conclusion, the reform of course content, instructional methods, and assessment strategies has effectively addressed multiple persistent challenges in the teaching of developmental biology. Future efforts will focus on continuously advancing the pedagogical framework to embed the philosophy of "student-centered development and autonomous learning" throughout the entire instructional process. The curriculum will be further optimized to encompass fundamental concepts, core principles, representative case studies, integrated applications, and frontier topics. Inherent ideological and moral elements within the knowledge system will be further explored to enhance the course's comprehensiveness, academic depth, and alignment with contemporary developments. The course is expected to evolve into a nationally recognized model of excellence, characterized by advanced educational concepts, rich content, innovative teaching approaches, and broad influence.

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References

[1] Shi J, Huang Y, 2020, Integration of Undergraduate and Graduate Education, Integration of Science and Education: An Important Way for Research Universities to Improve the Quality of Talent Cultivation. Higher Education of Sciences, 2020(3): 29–34.

[2] Li D, Lai W, Wang S, 2024, Exploration on the Training Mode of Innovative Talents in Key Laboratories of "Double First-Class" Universities. University Chemistry, 39(12): 150–155.

[3] Li X, Mou Y, Zhao S, 2025, Research on the Structural Characteristics and Optimization Strategies of

Interdisciplinary Integration Construction Policies in “Double First-Class” Universities. Journal of Nanning Normal University (Philosophy and Social Sciences Edition), 46(2): 107–120.

[4] Wang X, Wang R, Liu H, et al, 2023, Exploration on the New Management Mode of Experimental Teaching Demonstration Centers in the Construction of “Double First-Class” Universities. Journal of Higher Education, 9(2): 33–36 + 40.

[5] Huo Z, Yang Z, Li Y, et al, 2024, Research on the Influencing Factors of Undergraduate Research Participation Quality in “Double First-Class” Universities – A Case Study of Northwest A&F University. Higher Agricultural Education, 4(2): 45–53.

[6] Lu C, Qin Y, 2023, Analysis on the Characteristics and Development Path of Entrepreneurship Curriculum Construction in “Double First-Class” Universities – A Case Study of C9 Universities. Journal of Innovation and Entrepreneurship Education, 14(1): 97–106.

[7] Mao G, 2020, Research on the Construction and Management of National Experimental Teaching Demonstration Centers in Colleges and Universities under the Background of “Double First-Class” Construction. China Modern Educational Equipment, 2020(15): 31–33.

[8] Zhang S, Gao L, Yang Y, 2023, Dilemmas and Improvement Strategies of Mixed Teaching of Ideological and Political Education in College Courses. Theory and Practice of Education, 43(3): 57–60.

[9] Ding N, Li S, 2011, Discussion on the Reform of Experimental Teaching in Developmental Biology and the Cultivation of Innovative Ability. Journal of Biology, 28(3): 103–105.

[10] Chen Z, 2024, Analysis on the Teaching Reform of “Developmental Biology” Course Based on “Two Properties and One Degree”. Higher Education Forum, 8(8): 46–49.

[11] Zhong C, 2023, Ideological and Political Teaching in Developmental Biology Course. Modern Vocational Education, 2023(35): 157–160.

[12] Li W, Zhang Z, 2024, Reform and Practice of Developmental Biology Course for Biomedical Science Major. University Biology Teaching Research (Electronic Edition), 14(6): 29–33.

[13] Ministry of Education of the People’s Republic of China, 2020, Guidelines for the Construction of Ideological and Political Education in College Courses, visited on [date], http://www.gov.cn/zhengce/zhengceku/2020-06/06/content_5517606.htm.

[14] Anonymous, 2021, Ideological and Political Theory Courses Are Key Courses for Implementing the Fundamental Task of Fostering Virtue Through Education. New Long March (Party Building Edition), 2021(3): 4–13.

[15] Ren H, Lu Y, Zhang J, 2022, Research on the Reform Path of Curriculum-Based Ideological and Political Education From the Perspective of Integrated Talent Cultivation. China Higher Education, 2022(5): 31–33.