

# Improving the Teaching Effectiveness of Sports Biochemistry Course by the Integration of Scientific Research and Teaching

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**Abstract**—Sports biochemistry is a compulsory major course for Physical Education Majors in Colleges and universities. In the course of investigation and actual teaching, it is found that the traditional teaching methods and backward teaching contents and means of sports biochemistry are not suitable for the quality education concept which emphasizes the cultivation of students' innovative ability, resulting in the unsatisfactory teaching effect. In order to improve the teaching effect of sports biochemistry, this paper attempts to explore the role of integration of scientific research and teaching in the teaching of sports biochemistry by increasing experimental teaching hours, adding open research experimental teaching content, opening up the second classroom of scientific research experimental teaching, and increasing the proportion of experimental teaching assessment. Teaching practice shows that the organic integration of scientific research and teaching has played a beneficial role in cultivating students' innovative thinking, mobilizing students' learning enthusiasm and improving teaching effectiveness.

**Keywords**—sports biochemistry; teaching reform; integration of research and teaching; improving teaching effectiveness

## I. INTRODUCTION

Sports biochemistry is a branch of Biochemistry and one of the disciplines of sports science. It studies the adaptation of human chemical composition to sports, reveals the laws of metabolism and regulation of human substance and energy in the process of sports at the molecular level, and provides

scientific theories and methods for strengthening physical fitness and improving competitive sports ability by applying these laws [1]. Sports biochemistry is an important basic course in the training program of physical education professionals in Colleges and universities. It not only has rich theoretical knowledge, but also has a strong practical application, representing the forefront of the scientific development of sports human body [2].

In "Some Opinions on Improving the Quality of Higher Education in an All-round Way" issued by the Ministry of Education in 2012, it was clearly put forward that "to vigorously improve the level of personnel training, enhance scientific research ability, comprehensively improve the quality of higher education". Only by strengthening and deepening the cultivation of students' scientific research ability, and giving full play to students' practical operation ability, can we meet the needs of quality education. However, due to the limitations of various conditions in the cultivation of physical education professionals in Colleges and universities, the traditional teaching methods of Sports Biochemistry and the backward teaching contents and means are more and more unsuitable for the quality-oriented education concept which emphasizes the cultivation of students' innovative ability, resulting in unsatisfactory teaching effect [3]. Therefore, how to improve the teaching effectiveness of the course through the cultivation of students' scientific research ability in view of the problems existing in the current sports biochemistry course

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teaching has become an important topic in the teaching reform of university sports majors.

## II. THE ROLE AND STATUS OF SPORTS BIOCHEMISTRY COURSE IN THE TRAINING OF SPORTS UNDER-GRADUATE PROFESSIONALS

In the 1960s, sports biochemistry, as a professional basic theory course, formally entered the curriculum system of Higher Physical Education in China and played an increasingly important role. Its theory and method are the necessary basis of sports nutrition, sports psychology and sports training [1]. As a professional basic theory course interrelated with multiple disciplines, in the teaching process of sports biochemistry, we must adhere to the principle of comprehensive improvement of theoretical knowledge and practical skills so as to lay a solid foundation for the learning of other related courses.

In order to carry out the spirit of "Decision of the Central Committee of the Communist Party of China and the State Council on Deepening Education Reform and Promoting Quality Education in an All-round Way", the Ministry of Education promulgated the National Undergraduate Course Program of Physical Education in Universities in 2003 (hereinafter referred to as the "2003 Curriculum Program") and the Outline of Teaching Guidance for Main Courses of Undergraduate Physical Education in Universities in 2004 (hereinafter referred to as the "2004 Curriculum Outline"). It is the guiding document of the Ministry of Education on the curriculum construction of physical education specialty, as well as the important reference and basis for the relevant universities to formulate curriculum syllabus, organize teaching, carry out teaching evaluation, and implement teaching management and textbook construction. It not only reflects the characteristics of the times of the development of physical education discipline in the new century, but also plays an important guiding role in deepening the reform of Physical Education Specialty in Colleges and universities, strengthening the construction of curriculum system, improving the quality of education and teaching, and training physical education talents to meet the needs of quality education [4]. Sports biochemistry is included in the field of sports human sciences as the major compulsory courses in the "2003 Course Program" and "2004 Course Outline". In the talent training program, the main courses play a vital role in the cultivation of students' core professional knowledge and core competence. It is the core of professional construction and curriculum construction, and also the key to improve the quality of education and teaching [5]. Therefore, sports biochemistry course plays an important role in the training of undergraduate sports professionals, and it is also imminent to improve the teaching effectiveness of the teaching reform.

## III. UNIVERSAL PROBLEMS IN THE TEACHING OF SPORTS BIOCHEMISTRY

In the course of investigation and actual teaching, we found that there are some common problems in the teaching of sports biochemistry in China, such as lack of interaction in teaching means, lack of attraction in teaching content,

unreasonable arrangement of experimental teaching hours and design of experimental teaching, single way of performance evaluation, incomplete results of performance evaluation, etc. [6-13].

### A. *Lack of Interaction in Teaching Means and Lack of Attraction in Teaching Content*

Traditional classroom teaching methods are mainly taught by teachers, while the theoretical knowledge of sports biochemistry course is mostly concentrated on the micro-molecular level, which is more abstract than other main courses of sports human science such as sports anatomy, sports physiology and so on. Although multi-media teaching can be used to assist, because most of the students majoring in physical education have relatively poor science foundation, the students generally reflect that sports biochemistry is one of the most difficult courses to learn, and even difficult to understand. Often, they are not interested in the study of this course, lack of learning initiative, and lack of attention. It is difficult to form teaching interaction with teachers, which seriously affects the quality of classroom teaching.

### B. *Unreasonable Arrangement of Experimental Teaching Hours and Design of Experimental Teaching*

Sports biochemistry is an interdisciplinary subject of Biochemistry and sports science. Its essence is an experimental science and has a strong guiding role in sports practice. The teaching of sports biochemistry should adopt the mode of combining theoretical teaching with experimental practice. However, due to the lack of teaching resources and the limitation of experimental facilities, there is a general lack of attention to experimental teaching in departments of physical education in Colleges and universities [14].

According to the current experimental teaching plan of physical education departments in Colleges and universities in China, the experimental course of sports biochemistry usually has only 4-8 hours, and there is often no specific arrangement on the general schedule, which leads to the randomness of the experimental teaching content of sports biochemistry in different colleges and universities [14]. Due to the limitations of experimental equipment and venue and a few hours of experimental teaching arrangements, most colleges and universities can only design a few validation experiments to cope with the problem, and even some colleges and universities cannot even set up basic experiments, let alone comprehensive and research experimental projects. The experimental course eventually became a demonstration experiment of teacher's operation, which completely failed to achieve the teaching purpose of cultivating innovative talents [3].

### C. *Single Grade Assessment Method and In-complete Comprehensive Assessment Results*

For basic courses such as sports biochemistry, which have strong theoretical nature, students are usually assessed by the way of final closed-book examination. Although written examination is an important means of teaching evaluation, a single test score can only partly reflect the students' ability to

remember, and cannot well reflect the students' innovative thinking and operational skills. Therefore, the evaluation of students' learning effect and ability is not comprehensive.

#### IV. INTEGRATION OF SCIENTIFIC RESEARCH AND TEACHING TO CULTIVATE STUDENTS' INNOVATIVE ABILITY AND IMPROVE THE TEACHING EFFECTIVENESS OF SPORTS BIOCHEMISTRY

Since the end of 1960s, foreign higher education has tried scientific research-based teaching and carried out scientific research training for undergraduates. Practice has proved that scientific research-based teaching is an effective way to train innovative talents, which has been praised as "21st century teaching method" by European and American academic circles. At present, most universities in China still focus on teaching theory in classroom, neglecting the cultivation of students' scientific research ability, and rarely incorporating scientific research activities into the teaching plan [15]. In the training objectives and training plans of the undergraduate specialty of physical education, the "2003 Curriculum Program" clearly puts forward that "compound physical education talents should have innovative spirit, master basic scientific research methods and be capable of engaging in sports scientific research", which reflects the times and advancement [5]. Under the background and requirement of the times for training innovative talents, it is necessary to carry out teaching in scientific research, support teaching reform with scientific research, interact with teaching and scientific research, complement scientific research and teaching, and establish a training mode of innovative talents which integrates scientific research and teaching, the two functions of Colleges and Universities [16]. In teaching practice, in order to implement the document spirit of the Ministry of Education, cultivate students' innovative ability and enhance teaching effectiveness, and in view of the common problems in the teaching of the main course in "2003 Curriculum Program", Sports Biochemistry, we have explored the mode of integration of scientific research and teaching.

##### *A. Adjust the Syllabus to Increase the Teaching Hours of Experimental Teaching*

The "2004 Curriculum Outline" clearly requires that "experimental teaching should be strengthened, experimental design and ability training for comprehensive application of sports human science should be emphasized, and the ability to independently engage in scientific research should be strengthened". The original intention of experimental teaching is to cooperate with theoretical teaching, to let students intuitively understand the commonly used experimental techniques and means, to master practical experimental operation skills, and to learn to apply the theory of human science to analyze and evaluate experimental results. Teaching practice has proved that experimental teaching is an effective way to cultivate students' ability of scientific research and innovation. At the same time, it increases students' intuitive and interesting understanding of theoretical knowledge, and improves the actual effect of theoretical teaching. Therefore, we believe that experimental teaching is an important starting point to explore the integration of scientific research and teaching in teaching reform.

Under the condition that the total course hours of sports biochemistry remain unchanged, we can increase the proportion of experimental teaching hours to 25% of the whole teaching plan class hours from 12.5% by adjusting the syllabus, in order to transform the indispensable subordinate status of traditional experimental teaching of sports biochemistry courses and better play the role of experimental teaching in the cultivation of students' innovative ability. The adjusted teaching practice found that compared with the theoretical course, the students of physical education major participated more in the experimental course, and their exploratory spirit and practical ability exceeded our expectations. And the experimental design will be brought into the theoretical course teaching, the enthusiasm of students to participate in teaching interaction has also been significantly improved.

##### *B. Adjust the Experimental Teaching Plan and Add Research-oriented Teaching Content*

In order to promote the effective integration of scientific research and teaching, we have greatly adjusted the experimental teaching program. On the basis of the original validation and comprehensive experiments, an open research experiment was added. According to the principle of step by step, the experiment teaching is divided into three stages: the first stage is a basic experiment, designed for two hours, mainly through 1 to 2 confirmatory experiments to enable students to understand and master basic experimental operation skills, establish experimental safety normative operation awareness, and through experiments to verify the theory learned and deepen the understanding of knowledge points. The second stage is a comprehensive experiment, designed for two hours in teaching plan and extension delay after class. By instructing students to complete a comprehensive experiment, students will be more familiar with the various aspects of the experiment operation, enhance the ability of independent thinking, and improve the ability of using knowledge points to analyze and solve problems, paving the way for subsequent research experiments. The third stage is the open research experiment, designed for four hours in teaching plan and the time of the second class, and to instruct students to design and carry out exploratory research experiments by consulting relevant literature. According to the method of free choice, a number of research interest groups are formed, and the topic selection and experiment design are completed independently or assisted by the instructor. After discussion with the instructor, the feasibility is improved, and the experiment is verified. In the course of the research, the instructor strengthens theoretical and technical guidance, verifies experimental data, and timely evaluates and improves research programs, which fully embodies the scientific quality of students' seeking for differences and innovative thinking, and stimulates students' interest and creativity in learning. At the same time, through the organic integration of scientific research and teaching, students can achieve a comprehensive learning effect and improve teaching effectiveness.

### C. *Open Laboratories in An Orderly Manner and Open up A Second Classroom for Scientific Research-based Teaching*

After the addition of research-based experimental projects, the number of experimental class hours in teaching plan adjusted in the syllabus still cannot guarantee the implementation of such experimental projects. At the same time, the equipment, venues, opening time and funds of the teaching laboratory cannot meet the teaching needs. The opening of the second classroom of scientific research-based teaching can expand the teaching space and provide time and space conditions for students to carry out research experiments. On the premise of strengthening laboratory safety management, we can open teaching laboratories orderly to undergraduates, and in order to meet the needs of carrying out research experiment teaching, through the two-way choice between tutors and undergraduates, some students with potential for scientific research are allowed to enter the tutor's research laboratory to make up for the lack of scientific research conditions in the teaching laboratory. While applying for more experimental teaching funds from the school, the instructor can solve the problem of insufficient experimental teaching funds in many aspects by combining research experimental teaching with University Students' scientific research innovation projects, with his own scientific research projects, with the guidance of students' graduation theses, and with the guidance of students' postgraduate entrance examination, so as to complete the teaching guidance of research experimental projects.

### D. *Improve the Method of Achievement Assessment and Lift the Ratio of Experimental Teaching Assessment*

To a certain extent, the way of performance evaluation can affect students' learning attitude. In "2004 Curriculum Outline", it is proposed that evaluation of students' learning effect should combine final evaluation with process evaluation, combine theoretical knowledge evaluation with application skill evaluation, and combine students' classroom learning with their research ability. According to the practical subject characteristics of sports biochemistry, cooperating with the reform measures of scientific research-based teaching in this course, a reasonable teaching evaluation system should be set up, which should emphasize the examination of students' abilities and evaluate students' learning effects comprehensively. The experimental results should be regarded as an important aspect of the performance evaluation, and the proportion of them in the final performance evaluation should be increased, so as to enhance the students' attention and participation in the experimental teaching. At the same time, attention should be paid to process evaluation. In addition to the experimental report, the evaluation indexes such as experimental operation, experimental scheme design and so on should be added. The weight of each index can be adjusted according to the actual situation of teaching. This multi-dimensional performance evaluation method, which combines theory, practice and scientific research innovation ability, can be more in line with the goal of scientific research-based teaching to cultivate innovative talents.

## V. CONCLUSIONS

We have just made a preliminary exploration of the role of the integration of scientific research and teaching in the teaching of sports biochemistry. The organic integration of scientific research and teaching has played a beneficial role in cultivating students' innovative thinking, mobilizing students' learning enthusiasm and improving teaching effectiveness. How to make sports biochemistry and other major courses of sports human science play their due role in the training of sports professionals in Higher Education in our country still needs the joint efforts of colleagues in fraternal institutions to constantly improve and innovate teaching models and methods that meet the requirements of the times and provide new ideas for future teaching reform.

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