

# *Exploration on Implementing Quality-Oriented Education in Physics Teaching in University*

Yi Jin\*

Department of Physics  
University of Jinan  
Jinan, P.R. China  
ss\_jiny@ujn.edu.cn

Peng Song

Department of Physics  
University of Jinan  
Jinan, P.R. China  
ss\_songp@ujn.edu.cn

**Abstract**—Focusing on how to cultivate high-quality talents, aiming at improving students' creative thinking level and strengthening their innovative ability, and combining with the professional characteristics of physics teaching, this paper discusses in detail the contents of comprehensive quality education in physics teaching in universities from four aspects: scientific quality, scientific moral character, humanistic quality and physical aesthetics, and the reform and suggestions on how to implement them are put forward.

**Keywords**—*physics teaching in university; quality-oriented education; humanistic quality; innovative ability cultivation*

## I. INTRODUCTION

The most fundamental requirement of quality-oriented education is to enable students to develop morally, intellectually, physically and aesthetically in an all-round way. The Chinese government has always attached great importance to education, with particular emphasis on improving the overall quality of students. In June 1999, the Third National Conference on Education issued a programmatic document "Decision on Deepening Education Reform and Promoting Quality Education in an All-round Way" (hereinafter referred to as "Decision"). In this document, pushing quality education forward in an all-round way is the strategic focus of the education work in the new century, and improving the ability of innovation has been placed in an important position in relation to national rejuvenation and national prosperity. In May 2001, the State Council, in its document named by "Decision on the Reform and Development of Basic Education", emphasized that "we should deepen the reform of education and teaching and firmly promote quality-oriented education". It can be seen that the establishment of a new system of "quality-oriented education" is an urgent task of educational reform in the new century and a new subject for every teacher. Professional course teaching plays a unique role and function that can not be ignored in quality education. Professional course teachers should give full play to the advantages of professional disciplines and implement quality education in teaching. Physics is the basis of all natural and technological sciences. It integrates theory and experiment and is widely used in social life. Therefore, Physics teaching is an important part of quality education for the educatee. Its unique role and irreplaceability have been increasingly recognized and

valued by educators [1]. However, combining with the characteristics of physics, there is not much discussion on the content of comprehensive quality education suitable for the implementation in physics classroom, which is the main goal of this article.

Comprehensive quality education aims at improving students' ideological and moral quality, cultural quality, professional quality and physical and psychological quality. It is the core content of educational thoughts and concepts in the new period and the deepening of the all-round development of human beings in the new period. In order to implement quality education, moral education, intellectual education, physical education and aesthetic education must be organically unified in all links of educational activities. Taking this as the guiding ideology and combining with the characteristics of physics specialty, we believe that the quality education for students in teaching should include four specific contents: scientific quality, scientific moral character, humanistic quality and physical aesthetics [2]. The four are mutually reinforcing, interdependent and developing.

## II. SCIENTIFIC QUALITY EDUCATION

Quality education should first be scientific quality education. The Outline of the National Action Plan on Scientific Literacy (2006-2010-2020) points out that scientific literacy is an important part of citizens' quality. The basic scientific quality of citizens generally refers to the ability to understand the necessary scientific and technological knowledge, grasp the basic scientific methods, establish scientific ideas, advocate scientific spirit, and apply them to deal with practical problems and participate in public affairs. That is, the elements of scientific quality include scientific knowledge, scientific method, scientific thought, scientific spirit, science and technology and society. Just as the Nobel Prize winner in physics, German scientist Bonn said, "It is not so much because my published work contains the discovery of a natural phenomenon, but rather because it contains a basis of scientific thought and method in natural phenomena." Physics is recognized as an important science not only because of its profound revelation of the laws of the objective world, but also because it has formed a unique and effective ideological and methodological system in the process of development and growth. A large number of facts show that physical ideas and methods not only have value to physics itself, but also have

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important contributions to the development of the whole natural science and even social science.

The education of scientific spirit and scientific value helps to cultivate students' independence, realistic spirit, courage to overcome difficulties, and correct world outlook and values. In the specific teaching, teachers can combine the knowledge content of physics with the history of physics, the frontier of physics and the famous anecdotes of physics, so that students can not only learn physical knowledge, but also feel the great changes brought about by the development of physics to human society. This not only stimulates students' learning enthusiasm and initiative, but also enables them to comprehend the methods of scientific research and problem solving, which is very helpful and important to cultivate scientific qualities such as daring to ask questions, being good at questioning, being realistic and enterprising, and being brave in innovation, and to promote the formation of dialectical materialist world outlook. Of course, to do this, teachers are required to develop their own quality, have rich background knowledge, and have excellent teaching art at the same time.

In addition, the teaching mode of traditional experiment should be reformed in order to cultivate students' scientific quality. The traditional experimental teaching only takes the experimental course as a task to verify the theory. Almost all the experiments are previewed according to the textbooks. On the basis of the textbooks, students operate step by step under the guidance of teachers, and then the experimental reports are written 'faultlessly'. Students are totally in a passive learning state, and this rigid way can at most play the role of verifying and consolidating classroom knowledge, not to mention the cultivation of students' scientific ability and innovative consciousness. Faced with the demands for talents under the new situation, we must reform the current experimental teaching contents and methods, and set up design and comprehensive experimental topics that can cultivate students' innovative spirit and practical ability [3].

### III. SCIENTIFIC MORALITY EDUCATION

Scientific moral character is not innate, but is formed and developed through its own practical activities under the education and edification of society, family and school. Good scientific morality plays an important role in the development of human life. In the document of "Further Strengthening and Improving the Ideological and Political Education of Students in Universities" issued by the State Council in August 2004, it is pointed out that one of the main tasks of strengthening and improving the ideological and political education of students in universities is to carry out quality education in depth with the goal of the overall development of students in universities and to promote the coordinated development of their ideological and moral quality, scientific and cultural quality and health quality. In accordance with the above-mentioned spirit, teachers in physics class should educate students in scientific morality from the following aspects:

#### A. *Cultivating Students' Scientific Morality of Good Cooperation*

In physics teaching, attention should be paid to guiding students to learn to recognize, to learn to do things, to learn to live together and to learn to survive. Learning to live together means learning to communicate and get along with others. This requires learning to know and understand others. At the same time, students should learn to work with others and strive for a common goal. In essence, it is to cultivate people's spirit of cooperation. Nowadays, with the rapid development of science and technology, international exchanges and cooperation are increasingly frequent, and scientific and technological progress can not be separated from the spirit of solidarity and cooperation. Every scientific research project needs the close cooperation of every scientific research personnel involved. The famous Copenhagen School spirit and Cavendish Laboratory spirit in the history of science reflect this point. Cavendish Laboratory has a large number of talents. Maxwell, Rayleigh, Thomson, Rutherford and Bragg have successively assumed the leadership and trained 26 Nobel Prize winners. Bohr, the originator of Copenhagen School, also came from here. Bohr found a unique way of working. He didn't work alone. It is his greatest strength to surround him with the most active, gifted and visionary physicists in the world. Therefore, teamwork is fundamental to the success of scientific research and even individual success.

#### B. *Cultivating Students' Scientific Moral Character of Preciseness and Integrity*

While encouraging students to dare to think and pioneer, teachers should also train them to form excellent scientific research ethics and style of study so that they can understand that they should be highly responsible for their own actions in scientific and technological activities. They should be educated on the premise of respecting science and objective law, and to abandon unrealistic fantasies and unrealistic brutality. Such ugly acts as fraud, plagiarism and speculation should be firmly opposed. In recent years, incidents like the "father of cloning" of Huang Yuxi, a professor at Seoul University in Korea, have emerged one after another, which deeply reflect the current issue of academic integrity. The issue of academic integrity is fundamentally a matter of self-cultivation and the fundamental criterion of being a man. The crisis of academic integrity has brought immeasurable harm to society. As far as the university is concerned, it should be a place to cultivate talents with independent thinking. The degeneration of the style of study, the loss of honesty, the replacement of "research" by "plagiarism" and the loss of academic independence and creativity, will make the "university spirit" no longer be traceable.

#### C. *Cultivating Students' Scientific Morality of Devotion*

Students should be guided to devote themselves to scientific research, not to flow with material desires and not to be dominated by fame and wealth. Because scientific researchers are willing to devote themselves to poverty and serve the country, many scientific and technological innovations in New China can be created under very poor material conditions, such as "atomic and hydrogen bombs and

man-made satellite". Not only in China, but also in the history of world science, there are many examples of devotion to research. The curies' scientific achievements on the radioactive elements of Radium and Polonium, as well as the three most important scientific discoveries of the last century: Relativity, Quantum Mechanics and the double helix structure of DNA, were all worked out under relatively difficult conditions.

#### *D. Cultivating Students' Patriotism Spirit*

Patriotism Education is an important component of quality education [4]. The "Decision" emphasizes that school education should focus on the education of patriotism, collectivism and socialism, the education of excellent Chinese cultural traditions and revolutionary traditions, and the combination of carrying forward the fine traditions of the Chinese nation with actively learning all the outstanding achievements of civilization in the world. Shortly after the founding of New China, a large number of outstanding Chinese scientists broke through many obstacles, resolutely returned home and became the backbone of the scientific and technological development of the new red regime. Today, a large number of talents trained by Chinese universities have been lost to the United States and other Western countries. One of the important reasons is the lack of social and national sense education. Humanistic quality education plays an irreplaceable role in improving students' moral and cultural standards, enhancing their sense of social responsibility and patriotism, and shaping their healthy personality.

#### IV. HUMANISTIC QUALITY EDUCATION

Since the 1980s, western developed countries have reformed the previous "knowledge-centered" education, put forward the "human education" model, and attached great importance to emotional education and personal psychological quality education. It can be seen that introducing humanistic education into basic science education is the trend of the development of science education in the world and the need of social development. It embodies the idea of student-oriented development. The Ministry of Education promulgated the Standards for Physics Courses in Senior High Schools in April 2003, pointing out that physical classroom teaching should pay attention to the cultural value of physics, promote the formation of students' scientific outlook, and let students experience the "scientific value, application value and humanistic value" of physics. The purpose of the new curriculum is to promote quality education in an all-round way, so that students can have scientific and humanistic qualities.

Scientific spirit is a thorough materialist spirit, while the core of humanistic spirit is people-oriented, emphasizing human value and dignity, and paying attention to the infinite care of human situation. Both of them are the most precious and indispensable components of human spirit. To abandon the traditional narrow technical education and permeate the humanistic spirit into the scientific spirit and professional education will avoid utilitarianism and instrumentalization of science and technology, make people not slaves of science and technology, or make science and technology become accomplices to harm mankind, and let science and technology truly benefit mankind [5].

The infiltration of cultural character in physics teaching can also promote the construction of a harmonious society. Culture includes science, art, religion and other elements. Physics itself not only has the cultural characteristics of science, but also is the foundation of modern society, technology and culture. So physics is an inseparable part of culture. In China, the origin of physical culture can be traced back to more than 2,000 years ago, when philosophy and physics were mixed together. For example, when Confucius talked about physics from the perspective of education, he called physics "material character investigation" or "investigating material character". He believed that only by exploring and deeply understanding the truth of all things in the world, could he have firm beliefs, establish noble character, and then deal with the relationship between individual and family or society, and have a harmonious society. Not only Confucius, but also many ancient Chinese scholars believe that the studies of physics need careful observation, and deducing the laws of physics is endless fun, which can get rid of the shackles of fame and wealth, and make people to enjoy the joy of life.

#### V. PHYSICAL AESTHETICS EDUCATION

Aesthetic education is an important part of quality education. Its important position and role in quality education are mainly manifested in cultivating people's sentiments, promoting the internalization of psychological structure, improving thinking ability and training new talents. Aesthetic ability itself is a kind of high-grade innovative ability. Education should enable students to learn to examine the world, others and themselves with aesthetic eyes, and cultivate students' individual aesthetic ideals, tastes and abilities. The essence of classroom education is processes of stimulating aesthetic effect, which can inspires, shocks, infects and purify students' minds. "Physics Curriculum Standards" clearly put forward the requirements of aesthetic education in the curriculum objectives, so that students can learn to "maintain curiosity about nature, preliminarily appreciate the beauty and harmony of natural phenomena, and have a feeling of intimacy, love and harmony with nature" through physics. Therefore, in the process of physics teaching, attention should be paid to guiding students to appreciate the beauty of science, and then to pursue the beauty of science, so as to promote their intellectual development, enhance their desire for knowledge, cultivate noble sentiments and improve their scientific literacy in an all-round way [6].

Beauty in physics is the beauty of science, and the process of learning physical knowledge is just the process of appreciating the beauty of science. Scientific beauty is the free creation of human beings in the labor of transforming and conquering nature. This kind of beauty is not the beauty of natural image and scenery, but an inherent beauty expressed in harmony, symmetry, conciseness and singularity. The history of scientific development is the history of human pursuit and creation of beauty. Physics describes a wide range of objects, so its beauty is reflected in many ways. From the vast universe to the basic particles of the microworld, all are the objects of physicists' research. From galaxies to quarks, all follow basic physical laws. The beauty of Science in physics has many characteristics, such as simplicity, unity, accuracy, ingenuity,

conservation, symmetry, harmony, singularity and so on. Combining the basic principles of aesthetics with the evaluation and judgment criteria of scientific beauty, students can be guided to appreciate the beauty of the physical world from the following aspects:

#### *A. The Beauty of Theories*

In the history of science, Euclidean geometry, Newton mechanics, Kepler's law of planetary motion, Maxwell's electromagnetic unification, Einstein's relativity theory, Planck's quantum theory and so on, are called "works of art of science". In the description of nature in these theories, people can realize the beauty of harmony and simplicity. To sum up, the beauty of the theoretical system of physics is manifested in logic simplicity, internal symmetry, overall harmony, complementarity, universality and extensibility. These beauties attract countless people to devote their lives to them.

#### *B. The Beauty of Imagination*

Physical science is incredible without imagination. Einstein praised Bohr's model and law of the electronic shell in atoms as "the highest musical charm in the field of thought". Heisenberg once said, "The explorers of science often know and discover truth in the light of beauty, which is imagination."

#### *C. The Beauty of Experiments*

The experiment is one of the important methods of studying and learning physics. The design and implementation of every major experiment in the history of physics embodies the rich imagination and high aesthetic power of the experimenters. Many scientists have highly praised the ingenuity of the design of the Michelson-Morley Experiment. Einstein believed that the experiment "owes a great deal to Michelson's feelings and techniques towards science, especially symmetry and its form", and called him "an artist in science". Complex experiments are like this, while the simple dispersion experiment shows red, orange, yellow, green, blue, indigo, purple bands, which is also a scientific work of art.

#### *D. The Beauty of Landscape*

"Sitting on the ground and traveling 80,000 miles a day, patrolling the sky and looking at a thousand rivers", almost every physical discovery is accompanied by a beautiful physical picture, from the macroscopic astronomical landscape to the microscopic atomic structure diagram. Madame Curie believed that scientific exploration itself contained beauty, which made us realize the truth. This may be the reason why the Curies were gazing at the beautiful blue fluorescence of radium in the dark in their humble work shed. The beauty of new discoveries and inventions inspires scientists to devote themselves to science.

From the above discussion, we can see that the physics classroom is an important way to realize students' appreciation of scientific beauty; in the meanwhile, the appreciation of scientific beauty not only provides a positive emotional impetus for cultivating students' scientific quality, but also enriches and optimizes physics teaching. To achieve physical aesthetic education, it is necessary for physical teachers to have aesthetic sense first. Teachers should constantly strengthen and improve their aesthetic esthesis, aesthetic perception, aesthetic appreciation, aesthetic creativity and aesthetic expression. Zankov, a famous educator, said, "Only when teachers possess such qualities themselves - the comprehending and experience of the beauty in life and art, can they cultivate such qualities in students."

## VI. SUMMARY

In a word, from attaching importance to the unity of imparting knowledge and cultivating ability, then to the comprehensive quality education, it is a great development of educational thought and has a very important significance in the development of educational theory and practice. Quality education is a comprehensive project, while physics is a frontier subject. How to carry out and penetrate quality education in physics teaching, and how to organically link the content of quality education with physics teaching and run through the whole process of teaching, are the topics that physics educators must continue to explore and study in depth.

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