

# Study on promoting quantum mechanics-teaching modernization by information technology

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## ABSTRACT

**Quantum mechanics, one of the important theories of modern physics, is fairly esoteric and abstract. Based on the characteristics of the quantum mechanics course, the article studies the modernization of quantum mechanics teaching in four aspects: the modernization of the teaching idea, Computer-Aided Instruction, the development of Information technology software and the establishment of three-dimensional digital curriculum teaching resource library.**

**Keywords:** Quantum Mechanics; Information Technology; Modernization of Teaching

## 1. INTRODUCTION

Information technology is the general appellation of communication technology, computer technology, multimedia technology and network technology. In recent years, information technology has been applied in all walks of life, greatly promoting the social progress and economic development; meanwhile, it has also provided the more vast development space for higher education, thus bringing significant changes to higher education content, form, methods have undergone [1]. Quantum mechanics, as one of the two pillars of modern physics and the most important required course for physics majors, is an important basis for some post-graduate courses such as theoretical physics, materials science, laser physics and technology, bio-physics, and theoretical chemistry. Through the study of this course, students can master the basic conceptions and theories of quantum mechanics and acquire the ability to analyze and solve problems with the basic theories of quantum mechanics. But it is very difficult for the beginners to accept the theory, for it is fairly esoteric, abstract and complex. Modern information technology can integrate and

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construct an ideal learning environment effectively, which can support the creation of the real situation, the sharing of resources without the limit of time and space, the fast and flexible obtaining of information, and the interaction of rich resources, thus leading to new learning methods such as research-based learning and cooperative learning, and achieving the goals of deepening the teaching reform and training innovative talents. So the introduction of information technology in the teaching of quantum mechanics can effectively promote the modern teaching of quantum mechanics.

## 2. UPDATE THE IDEA OF TEACHING, AND ENHANCE THE UNDERSTANDING OF MODERN TEACHING TECHNIQUES

Education modernization demands not only the renewal of equipment and technology but also of the teaching idea. Updating teaching idea is to change the educational idea, teaching content and teaching methods, which are behind the times. Traditional teaching is based on the basic purpose: teaching students knowledge, telling students the way to live and answering students' questions, and teaching knowledge is the fundamental goal of teaching. This old teaching model and teaching idea do not fit in with the law of education and hinder the improvement of the students' physical quality, thus being not conducive to the cultivation of talents. To cultivate talented personnel of high qualities who meet the new age's needs and intense competition, we must reform education ideology, instruction content and instruction means. Computer is the basis and the core of modern science and technology. Mankind has entered the computer age and the information superhighway era. Moreover, more than 90% of the invention and development of the world science and technology is closely linked with the computer technology in recent 30 years. It can be said that commanding the knowledge of computer is an essential quality for the future talents. As for the requests for the next generation of young people, the em-

phasis should not be put too much on the amount of the knowledge they have reserved, but on their ability to obtain knowledge.

Computer and software are the crystallization of the wisdom and a valuable knowledge product. As an important component of modern teaching technology, Computer is introduced to classroom teaching and family tutoring, which will not only be good for us to strengthen the times, competitiveness and pathbreaking of the teaching and to face the challenges of a new era, but also help students form new ideas, new concepts and new methods in the learning process, which is very important for them to become a high-quality personnel in future.

### 3. THE MAIN WAY TO PROMOTE THE TEACHING MODERNIZATION BY INFORMATION TECHNOLOGY

#### 3.1. Computer-Aided Teaching Enriches the Class Teaching Method

The enrichment of quantum mechanics teaching content, the decrease of teaching hours and the improvement in the request of talent training quality make the contradictions of the teaching enforcement process more obvious, so it is essential to put forward the best solution to solve the problem to enhance the effectiveness of teaching. There are some obvious shortcomings in traditional class teaching and the lag of teaching technology led to rigid forms of class teaching. The original teaching pattern, in which teachers teach and students listen and take notes, hindered the students' interest in study. Therefore it is necessary to change the writing on blackboard simply into electronic teaching plan, writing on blackboard, video, CAI, demonstration of the experiment and the network to achieve the best teaching results. It is worth mentioning CAI, the character of which is the visualization and diversification of teaching content, the rigorous and scientific nature, the unified applicability and timely interaction, which favors the implementation of individualized teaching. CAI, as an effective means of modern teaching, is getting more and more favor of teaching workers. The emergence of CAI brought a vitality for class teaching, and its powerful demonstration function can not be compared by traditional equipment.

#### 3.2. Digital Software Development for Typical Teaching Content

Quantum effects, quantum model, quantum theory, quantum computing, quantum experiment and quantum application in quantum mechanics are very difficult and abstract to understand, so the teaching effect has been less prominent. But it has been proved by practice that the development of proper software for teaching will

achieve better results.

#### 3.2.1. Make Full Use of the Three-Dimensional Demonstration of Information Technology to Learn Abstract Wave Function

Comparing quantum states with the state statistics in the teaching of wave function, accepting wave function with the idea of distribution function is called the probability density [2]. Then, make a surface of the equivalent probability density, and the probability of emergence of micro-particles is equal. It will be fine to find the dot  $(r, \theta, \phi)$ , which satisfies the equation  $\psi[r, \theta, \phi] = const$ , and then to run the dot in a smooth surface (Figure 1, Figure 2).

#### 3.2.2. Play a Numerical Calculation and Simulation Capabilities to Achieve the Strengthening of the Basic Concepts of Quantum Theory and the Experiment Content in the Classroom

Movement of micro-particles is random in general. The description of the motion of the wave function is the probability (density) range, and eigenvalue and eigenstate reflects the side of movement determinism. That is, the measured corresponding value of physical quantities is determined when the particle is in a mechanical eigenstate.

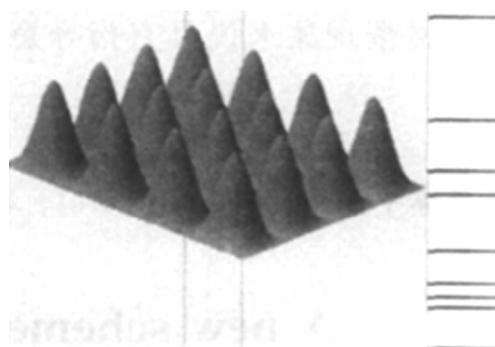


Figure 1. Probability density two-dimensional infinite well wave.

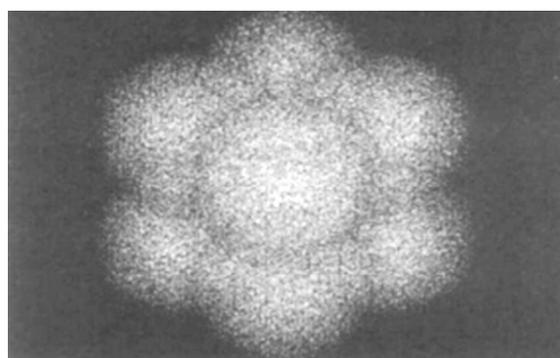


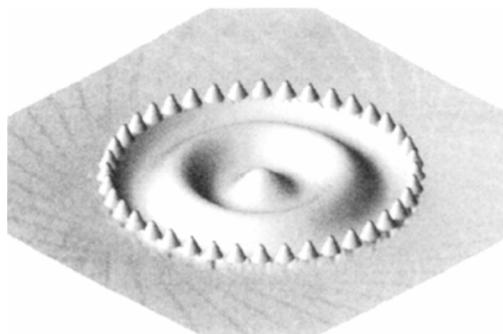
Figure 2. Three-dimensional infinitely deep well the probability density-wave.

The calculation and solving on eigen equation, the eigenstate and eigenvalue of the mechanical quantity is the important teaching content and methods to understand the basis of quantum theory. However, it is difficult to study when facing the energy spectrum of one-dimensional finite deep square potential trap, so we can make a potential trap spectrum distribution of different wide with digital technology (**Figure 3**). We will feel more relaxed by studying the energy spectrum of one-dimensional finite deep square potential trap by diagram.

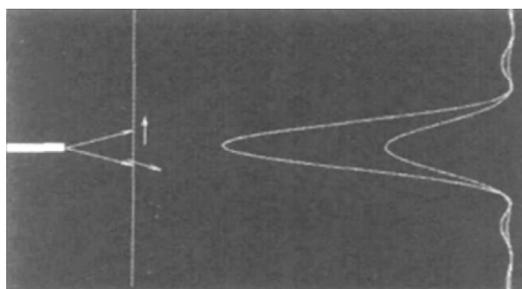
In addition, when introducing the teaching of quantum experiments [3], we can take full advantage of the digital calculation and simulation technology to show students quantum fence and quantum decoherence, which are difficult to understand, and instruct students to realize the simulation by programming (**Figure 3**, **Figure 4**). The technology is also widely used in the teaching Spatial Orientation quantization of angular momentum, two-dimension brillouin zone of energy band theory and comp-ton scattering experiment with perfect teaching result.

### 3.2.2. Set Up Three-Dimensional Digital Teaching Resources of Quantum Mechanics

The characteristics of college students learning are the combination of class learning with extra-curricular learning. But extra-curricular learning resources in many schools are the teaching plan of teachers and the answer to exercises, etc, which can not provide effective help to



**Figure 3.** Quantum corral.



**Figure 4.** Quantum decoherence.

students. Information technology has been promoting the reform and innovation of the traditional audio-visual and computer-assisted education since the mid 90s of last century. Fine quality learning resources on quantum mechanics can be found in network learning resources at home and abroad at present and the resources are very rich; therefore, we can collect high-quality digital teaching resources about quantum mechanics at home and abroad, and then select, integrate and create the existing digital teaching resources by combining the teaching practice with teaching research of chief teachers in accordance with the new education ideas, with the aid of modern information technology to build three-dimensional digital resource library and at the same time to assist the teaching resources on the Net which include teaching software, management software and Information Consultation. It is especially important to establish the multi-dimensional database of information integrable ware according to the thought of the integrable ware, and teaching on Net becomes true by using the integrable ware to assemble a platform. Provide students with a broad three-dimensional self-learning space for students' extra-curricular learning. (Shandong Province, the provincial Quality Course Digital Web site of quantum mechanics: <http://222.133.5.50/kc/lzlx/index.php>)

## 4. CONCLUSIONS

Nonesuch Courses Building is one of the important contents of the Project of Teaching Quality and Teaching Reform in Colleges, the aims of which is to improve the teaching quality and the quality of personnel training [4]. Information technology is a powerful backup of the realization of the teaching modernization and a necessary condition of Course Construction. It can be predicted that the further development of information technology will promote quantum mechanics-teaching modernization to a higher level.

## REFERENCES

- [1] Zhou, H.C., W, Y.X. and Zhu, S.H. (2009) Research and practice of promoting university teaching reform of information technology[J]. *China Education Info*, **1**, 67.
- [2] Li, Y.J., Zhong, J.H. and Liu, Y. (2007) Application of digital technology to teaching quantum theory for students of engineering. *College sics.*, **26(4)**, 1.
- [3] Li, Y.J. and Chai, K.M. (2005) Digital Physics Demo. BeiJing: Higher Education Press, 78.
- [4] Hua, (2008) Carry out action research, create quality courses. *Education and Vocation*, **32**, 11.