Reform of Quantum Mechanics in Information Specialty by Computer-Aided Practice

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Abstract. Quantum Mechanics is an important compulsory and basic course for students who study in information science specialty, and it also the theoretical basis of modern physics and modern engineering technology. Because many basic concepts of quantum mechanics are different with those in classical physics, these bring difficulties in understanding for students. In the traditional teaching pattern, theory teaching is over-emphasis while practice teaching is less. So there is necessary to reform the quantum mechanics teaching pattern. With the introduction of computer-assisted practice, it will deepen the students understanding on nonobjective conception and comprehensive theory. In this paper, the tunneling effect in quantum mechanics is used as an example. All students were required to demonstrate the tunneling process by using Matlab software, this practice process increases the understanding of the theoretical knowledge in Quantum Mechanics.

Keywords: Engineering education, information science specialty, quantum mechanics, reform and practice.

1 Introduction

Higher engineering training plays a very important role in industrialization and modernization process in China and makes important contributions for economic and social development. Till now our college engineering education has achieved great progress, but there are still some problems as listed: ①The research on engineering training is not sufficient and the theoretical guidance for engineering training is still lack. ②There exist the problem of insufficient investment in engineering education both for the government and the college. For the equipment, knowledge, and technology involved in engineering training update quickly, these demand higher standard teaching and practice requirement. More investment is needed. ③The content and methods of engineering education is too obsolete, which unable to meet needs of the developing technology. ④Fewer practice opportunities. The theory and practice teaching are separating from each other, and the theory teaching has an absolute majority proportion. The multidisciplinary training course is rare [1].

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In information specialty in School of Science, Wuhan University of Technology, two directions--named the optical information science and technology and the electronic information science and technology were set up. The purpose of the whole training system aims to cultivate the people who will master the basic theory, knowledge and skills in Optical Information Science and Technology, Electronic Information Science and Technology. These people will work in optical communication, optical information processing and the related electronic information field. In the future they can do the jobs such as scientific researcher, R&D personnel and managers in such industries. Accordance with the training mode "deep foundation, wide caliber", the quantum mechanics course was selected as a basic core course for students. We consider that this course, on the one hand, will lay the important physical basis for students; on the other hand, it will train students with scientific way of thinking and research method. But in real teaching processes, we found that most students can hardly understand and accept the contents of quantum mechanics. This is partly due to the research objects of quantum mechanics focuses on the microscopic particles. The relevant theory is too abstract and difficult to understand; in the other hand, now the students are more interested in practical training. But the physical process of micro-particle and physics theory in quantum mechanics can not be directly observed. And the relevant practical teaching is lack, which affect initiative learning of students.

With the rapid development of computer technology, it is possible to introduce practical teaching into the teaching process of quantum mechanics. Combining computational physics methods and the powerful function of the computer graphics software, we will encourage students to design demonstration experiments related with quantum mechanics by themselves [2]. By this method, it will increase dynamic and visual representation form in this course, making the nonobjective theory into practical one. In addition, this method will consolidate learning effect and train the practical skills and innovative spirit of students. In the following, the tunneling effect in quantum mechanics was used as one example.

**The introduction of tunneling effect.** Tunneling effect is one specific physical phenomenon in quantum mechanics. According to classical mechanics, if a particles with energy E is shooting toward a square potential barrier, when E is lower than V_0 (the height of the barrier), the particle can’t penetrate the barrier and it will rebound back; when E is higher than V_0, the particle will pass through the barrier. But in quantum mechanics, particle is usually considered equivalent to wave. Considering the wave character of the particle, particle often has some chance of penetrating the barrier and certain chance of being bounced back, no matter how high the barrier height. The phenomenon that any particle can penetrate the barrier with higher energy than its kinetic energy is tunneling effect. This phenomenon is attributed to the wave character of the particle.

For one-dimensional square potential barrier as shown in Fig.1, a particle with energy E is shooting towards the square barrier along the x-axis direction. The parameters for the barrier are: