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Methodology Article

The Realization of "College Physics" Teaching for Non-Physics Major Students

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Abstract: Physics is an exciting, living, discipline that continually moves in new directions. College Physics is a very important course for scientists and engineers. According to the study of Physics teaching experience, authors believe that the goal of studying Physics for non-physics major students is the application of Physics. Using the thinking fashion, research method and knowledge of Physics enhances student's science accomplishment, innovation ability, obtaining knowledge in other fields and scientific literacy. In Physics learning, students obtain the ability of raising the question, analyzing and solving the question, and therefore which has a significant influence in their major or profession in future. Do not teach non-Physics major students with the pure professional teaching mode of Physics. Physics course should be combined with the specialty of students; also the contents of physics course should be kept in a basic system. The culture in physics, such as philosophy, is very important in the study of special knowledge of physics. Physics teachers should pay attention to teaching and scientific research, and promote each other. Teacher should cultivate students' ability of thinking and expression, and train students in scientific thinking, etc.

Keywords: College Physics, Non-Physics Major, Physics Teaching

1. Introduction

Science is the body of knowledge that describes the order within nature and the causes of that order. Science is also an ongoing human activity that represents the collective efforts, findings, and wisdom of the human race, an activity that is dedicated to gathering knowledge about the world and organizing and condensing it into testable laws and theories [1]. "At every crossway on the road that leads to the future, each progressive spirit is opposed by a thousand men appointed to guard the past." An understanding of science begins with an understanding of Physics. The concepts of physics reach up to more complicated sciences, such as chemistry, biology, etc. Physics is an exciting, living, discipline that continually moves in new directions: biophysics, nanophysics, and experimental cosmology are all areas which did not exist until relatively recently. Some of the greatest challenges now facing, such as how to manage dwindling resources of fossil fuels and how to control/mitigate global warming, require a deep understanding of physics. Additionally, the modern physics has had a profound influence on people's lives, both intellectually and technologically.

Physics is the core of natural science and source of new technology. Physics is not everything but everything cannot work without Physics. The characters of Physics are: concision, harmony, symmetry, unification, vivid, and liveliness. "If you hate physics, it's not your fault: maybe the teacher is not good [2]." Physics contains three levels of contents: thinking mode, research method, and knowledge. Without the knowledge of Physics, one will have trouble in understanding the Physics thinking mode and research method.

Up to now, the universe is about 13.7 billion years, the solar system is about 5 billion years old, human beings have a recorded history of about 5,000 years, and science has entered quantitative research for only 400 years. In order to understand these times more vividly, if we use 24 hours to

represent the universe's 13.7 billion years, then the 400 years of science entering quantitative research is only 0.0025 seconds. People try to figure out everything that happened in the past 24 hours in 0.0025 seconds. Just imagine how hard it is. Therefore, the current understanding of the world is superficial, naive, inaccurate, and even wrong. Science is an approximation. People's understanding of science is deeper and deeper. Physics is a work in progress and isn' t finished. Knowledge is provisional. There are always new ways to solve a problem, and there is always more to be studied.

2. Understanding of Physics Teaching Related Issues

The brain is a torch that needs to be ignited, not a filled container. Inducing human creativity and cultivating innovative talents is one of the important purposes of physics teaching. Einstein said: "The so-called education is the skills left after the entire content of the school to forget." The physicist Laue also has a similar expression. Is Einstein's understanding of education acceptable? If it is acceptable, the question to be thought about is: What is the "things left" after class? How can teacher give students more? Teacher should stress creativity of students. The student discusses the ideas, thinks about the things, and talks about the things.

2.1. Learning Physics

There are several ways to study physics, namely reading, thinking, and practice. At the same time, it focuses on cultivating students to ask questions, focus on discussion, expression and display. There are two main ways to study physics theory: reading, thinking. Reading and thinking complement each other, especially as the two legs of a person, both are indispensable. The purpose of the teacher's lecture should help students clear the barriers to reading the textbook instead of reading it. From a philosophical point of view, students are internal and fundamental in the whole process of learning; teachers are external factors and conditions. How do teachers create a kind of way for students to "not simply instill knowledge, but to let students start thinking and researching", which is worthy of teacher's research and thinking.

In the teaching process, teachers should develop students' ability to ask questions, express and display, and establish students to actively participate in the learning-oriented teaching mode. Learning from the teaching methods of famous universities in the United States, using peer instruction [3-7], flipped classrooms [8], etc.; In the class, improve the degree of students' participation in classroom learning; self-investigation and learning, and scientific method training.

2.2. Pay Attention to the Training of Thinking Mode

Physics consists of three levels of thinking, research methods and knowledge. In physics teaching, not only should teach physics knowledge in books, but also teach physics thinking methods and research methods that are not available in books. As Einstein said, "In school, the value of education is not to learn a lot of knowledge, but to be trained in how to think, and this is impossible to learn from books" [9]. A robust alternative to traditional teaching is one that prioritizes creative thinking. That is the approach that Feynman strongly emphasized. Feynman's way of teaching is perhaps best described in three words: learning by creating [10]. The famous scientist Gao Shiqi made it clearer, "Thinking science is the science of cultivating talents. One of the most important factors in cultivating a person is thinking, and thinking in science. Simply instilling knowledge and technology without a correct way of thinking to summarize and guide the application is not a qualified talent for development. It can only lead to a generation of people with rigid minds and lack of resilience and creativity.

Einstein used the free thinking to re-examine the concepts of "time", "space" and "mass" that have been established for thousands of years, and proposed two basic assumptions: the principle of relativity and the principle of constant speed of light. A special theory of relativity was established.

Physics helps students to understand the world correctly, master the correct methods of understanding, and develop students' ability to think independently and judge independently. Physics plays an irreplaceable role in cultivating people's scientific worldview and improving people's scientific quality. Some excellent universities at home and abroad, the departments such as humanities, economics, education, medicine and life sciences, earth and environmental science, law, finance and economics, business management consulting, philosophy, national policy, etc., also offer physics courses, known as "General knowledge" physics course. The physics curriculum is designed to meet the professional content and requirements of the students. The physics curriculum is rich in content, from easy to hard, step by step, and students have a certain foundation before learning difficult courses. Undergraduates participate in scientific research and training, and have specialized courses to train students' experimental research and data analysis.

2.3. Pay Attention to the Training of Research Method

The famous Russian scientist Pavlov once said: "Science is advancing with the achievements of research methods. Every step of the research method, people will improve one step further, and then will open up a full with a broader vision of new things, the first and foremost task is to develop research methods." Using a good method can do more with less effort, and improper methods often result in half the effort.

For example, De Broglie uses an analogy approach to propose that particles also have wave-particle duality. The Frenchman Louis De Broglie originally studied history, and his brother was a physicist who studied X-rays. Influenced by his brother, he became interested in physics. De Broglie notes that the motion of light in geometric optics obeys the principle of the shortest path of light; in classical mechanics the motion of a particle follows the principle of minimum action of mechanics; these two principles have similar mathematical expressions. The development of physical optics at that time has proven that light has wave-particle duality. In 1924, De

Broglie made an analogy between optical phenomena and mechanical phenomena: he suggested that particles also have wave-particle duality, that is, particles also have volatility, and such fluctuations are called matter waves. Then De Broglie's further analogy, the wavelength of light is $\lambda=h/p$ (p is momentum, h is Planck's constant); since the matter particles have duality, the wavelength of the matter wave should be similar to the light wave. That is, $\lambda = h / mv$ (mv is momentum, h is Planck's constant), where λ is the wavelength of the matter wave. The prophecy of De Broglie was confirmed in 1927 by experiments such as electron diffraction.

As Pavlov once pointed out: "With good methods, even those who do not have much talent can make many achievements. If the method is not good, even a talented person will accomplish nothing."

2.4. Learning Physics to Learn Some Philosophies

The original meaning of "Physics" is natural philosophy. Teaching physics must teach some philosophy, and learning physics should learn some philosophies. To learn from nature and to draw inspiration from the principles and laws of physics, and which has an irreplaceable role in cultivating a scientific worldview and improving scientific literacy.

Example 1, "gravity" is fair and equal for all people, but each of us weighs differently. This small example tells us the truth: "equality" is not the same as "identical." These two concepts are often confused by person.

Example 2, the second law of thermodynamics: $Q_1 = W + Q_2$ In thermodynamics: Q_1 is the heat provided by the high temperature heat source, W is the work done by the system, and Q_2 is the heat released by the system to the low temperature heat source. When applying the second law of thermodynamics to economic development of the country: Q_1 is resource consumption, W is gross national product (GDP), and Q_2 is the impact on the environment. The factors that constrain the gross national product (GDP) are resource issues and environmental impacts.

Physics is a river of flashing thoughts, and every glorious place embodies the crystallization of the wisdom of scientists. In teaching, pay attention to the history of physics [11], scientific literacy [12] the narration of physicists' personal deeds, particularly, the skepticism and critical spirit of physicists in experimental facts or experimental results. Nature rarely gives a straight answer. So researchers in science sometimes follow blind paths and usually need trial and error and second guessing [13]. Combine the research experience of scientists to cultivate students' spirit of advocating science. Physics has a rich humanistic heritage. In its various theorems, formulas and concepts, there are various experiences in which human beings understand nature and transform nature through various means. Therefore, in physics teaching, it is necessary to combine humanistic quality education, to introduce students to the noble moral character of famous physicists in history, and to cultivate students' doubt and critical spirit in the learning experience. In this way, students can develop in a comprehensive, harmonious and healthy manner.

2.5. Don't Use the Physics Teaching Mode to Teach "Non-Physical Students"

The new teacher did encounter difficulties in class. Some new teachers are prone to greed and quest for a lot of time. They introduce mathematical inferences and proofs in large numbers. They cannot grasp the errors of in-depth analysis of typical problems. The result is that "some physicists hide their physics knowledge in the fog of mathematics. Scared the layman away".

2004 Nobel laureate Vercek said: "You don't have to compose like Mozart in order to appreciate the wedding of figaro". Similarly, You don't have to be proficient in the technical details of modern physics in order to enrich your life with wonderful modern physics concepts" [14]. Einstein's famous saying: "Everything should be as simple as possible, but not too simple" [15]. This applies equally to physics textbooks and physics courses. Physics is not mathematics. Mathematics is the "tool" of physics; but without mathematics, it is impossible to fully understand physics.

Stimulate students' interest in learning physics, and closely link physics learning with professional development needs, so that students can appreciate the importance of physics in the majors of students and enhance the subjective initiative of students in learning physics. This is an important means to effectively improve the quality of teaching in university physics courses. There are some effective methods for teaching traditional physics, such as the Socratic method or discussion method. Instead of writing and solving equations, the students engage in a more intuitive discussion of the main concepts and their relevance to natural phenomena and the applications and devices used regularly [16]. The physics class can be the most fascinating or the most annoying, just look at how to design this class.

2.6. "University Physics" Course Should Be Combined with the Profession and Maintain a Basic System

In the 1930s, Compton as the president of the Massachusetts Institute of Technology said: "There is no first-class engineering school without a first-rate science school." In excellent universities, "physics should be the main discipline of the school; The mainstream discipline of the school should be the support of physics. That is, physics should constantly provide new ideas and methods for the mainstream disciplines of the school, and mainstream disciplines should constantly provide research questions for physics." Without a multidisciplinary cross-integration, schools are hard to become top universities.

Using physics thinking, research methods and knowledge to improve students' scientific literacy, innovation ability and ability to acquire knowledge are common problems in physics teaching. Using physics thinking, research methods and knowledge to study students' own majors is a personality problem in physics teaching. The physics study is closely related to the professional development needs, so that students can understand the importance of physics in their majors. For example, For the physics of students in health profession,

physics knowledge of diagnostic and therapeutic tools can be taught, such as blood pressure, nuclear magnetic resonance, magnetoencephalography, positron emission tomography, ultrasound, radiation therapy, etc.

Physics consists of three levels of thinking, research methods and knowledge. It is difficult to understand the way of thinking and research methods of physics without learning knowledge of physics. For example, without "relativity", how to understand the way of thinking of relativity - free thinking? How to understand the research method of relativity - exploratory deductive method? Physics cultivates an imagination. The content of the "University Physics" course must maintain a basic system. Focusing on the content of modern physical relativity and quantum physics, the teaching content keeps pace with the times.

2.7. Combination of Scientific Research and Teaching Work, Cultivating Students' Scientific Thinking Ability

The famous scientist of China Qian Weichang once said: "If you don't go to class, you are not a teacher. If you don't know how to do research, you are not a good teacher. Research reflects whether someone is clear about the subject or not. If teaching does not have a scientific research foundation, it is an education without the opinions and the soul." Qian Weichang's words are not long, but the analysis of the relationship between teaching and scientific research is very thorough. Physics teachers should participate in scientific research, and scientific research work is the most effective in thinking, analyzing, and judging. The method of scientific research is to conduct teaching research. Students are encouraged to read relevant scientific research papers and the latest international scientific research progress. Teacher should expand students' knowledge horizons, increase students' professional knowledge and English knowledge reserves; conduct scientific research training for students. Students select topics, design experiments by themselves, and conduct experiments to prepare for scientific research in advance.

Guide students to discover the beauty of physics and stimulate physical learning interest. Bring scientific research ideas and methods into the classroom, let students learn to think, learn to acquire and process information, learn to discover problems, propose, analyze and solve problems. Teaching knowledge in the teaching process is also teaching methods, cultivating self-learning ability, abstracting problems, analyzing problems, solving problems and their methods of thinking. Help students to complete the transition from students to scholars as soon as possible.

3. Conclusions

This paper introduces the understanding of the issues related to effective physics teaching for non-physical students: learning physics should pay attention to the training of thinking methods and research methods; focus on cultivating students' thinking ability and expression and display ability; The "University Physics" course should be combined with the major, and its content should maintain a complete knowledge system; pay attention to the application of physics by non-physical students, and improve students' science with physics thinking, research methods and the ability to acquire knowledge. Pay attention to the cultural characteristics and philosophical nature of physics teaching; Don't use the physics teaching mode to teach "non-physical students". Combine scientific research with teaching work, cultivating students' scientific thinking ability. Help students to complete the transition from students to scholars as soon as possible.

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