

# On the Teaching Reform of College Physics in the Information Age

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**Abstract:** *Taking the authors' college as an example, the prominent problems of college physics teaching for undergraduates have been analyzed based on the background of the reform of National College Entrance Examination (NCEE). The countermeasures are proposed actively. Based on the technical advantages in the information age, college physics teaching reform has been studied. In terms of teaching mode, combination of online and offline teaching mode is adopted; In terms of teaching means, modern means of science and technology to demonstrate the course content are adopted; In terms of teaching direction, the specialized direction with the integration of professional characteristics and foundation is adopted.*

**Keywords:** *College physics, teaching reform, information age*

## 1. Introduction

Physics provides theoretical basis for all kinds of engineering technology which have been promoting to develop rapidly. Therefore, mainly all institutions of higher learning have set college physics as compulsory common basic courses for the science-and-engineering students. Under the promotion of the development situation in the era of knowledge economy, institutions of higher learning, especially application-oriented colleges, have changed the training target from academic type to applied technology type [1-2].

The change of teaching targets will inevitably bring about new changes in physics teaching. Thus, the teaching reform of college physics must be undertaken. In fact, the model of life and education in today's society has been changed at an alarming speed by the contemporary information technology which is represented by multimedia and Internet. Especially under the novel corona-virus epidemic situation, the teaching method has been undergoing extensive and profound changes. Furthermore, the traditional offline teaching mode has encountered great innovation. The rapid development of the information age provides a strong technical support for the educational reform [3-5]. The emerging information technology makes it more convenient for students to obtain digital resources. In order to facilitate students' learning and realize information sharing, various information-based teaching methods and software have appeared, such as MOOC, micro class, rain class, cloud class, etc. How to adapt to the above changes and ensure the quality of teaching is an urgent and important issue for front-line teachers.

Based on the realistic learning situation of students for physics as well as the characteristics of the information age, the paper attempts to discuss the direction and concrete implementation of college physics teaching reform. First of all, we presented some problems in college physics teaching by investigating the learning situation of the students. Then, it is discussed that how to launch college physics teaching under the background of information age.

## 2. Analysis of students' learning situation

Our college takes serving the economic and social development of Beijing as its own responsibility, which aims at cultivating high-quality applied talents. It strives to build the college into a regional university with distinctive characteristics of engineering. As a compulsory common basic courses for most non-physics majors, college physics plays an important role in the cultivation of students' scientific quality, innovation ability and exploration spirit. The teaching time of college physics is generally set in

the second semester of freshmen and the first semester of sophomore. In our college, the students in every teaching class are investigated at the beginning of the courses. According to the statistical analysis, there are some prominent problems which need to be considered seriously (taking the 85 students majoring in materials science of grade 2019 as an example).

The Reform of National College Entrance Examination (NCEE) System in China has been playing a profound impact on the depth and breadth of physics teaching. More recently, the mode of NCEE has changed from the previous '3 (Chinese, Mathematics, English) + X' to the new mode of '3 (Chinese, Mathematics, English) + 3'. In the original mode of NCEE, 'X' refers to comprehensive arts-related subjects or comprehensive science subjects. For comprehensive science, three NCEE courses of physics, chemistry and biology are integrated into one examination paper. However, in the new mode of NCEE, the latter '3' refers to arbitrary three courses from the six ones which are as follows: politics, history, geography, physics, biology and chemistry. Comparing the two modes mentioned above, it can be seen that the proportion of physics in NCEE has decreased for science-and-engineering students. Especially in the pilot areas where the new mode of NCEE is implemented, there is a phenomenon that physics will not be chosen by more and more students. Thus, there are many new changes in the physics teaching in senior high school. Firstly, the decline in the proportion of physics examination reduces its importance to NCEE, which may have adverse effects on students' learning foundation. Secondly, some senior high schools have began to offer physics depending on the students' interests, in terms of elective form. As shown in Figure 1, for the students majoring in materials of grade 2019, 94% of them are required to learn physics in senior high school, and a few (6%) are elective. Fortunately, according to the survey, the number of students who haven't taken part in physics in high school is zero. On the whole, physics teaching in senior high school has been diversified along with the change of the mode of NCEE, which brings some difficulties to college physics teaching.

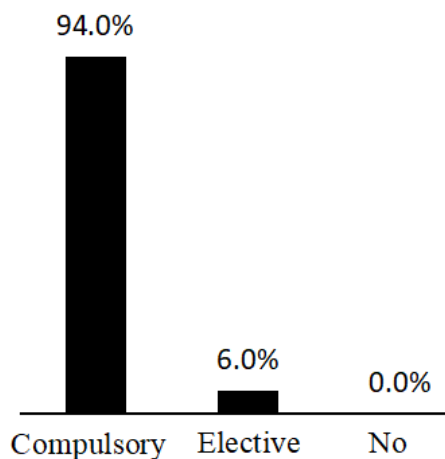


Figure 1 Bar chart of senior physics foundation survey for students of grade 2019 in Materials Major.

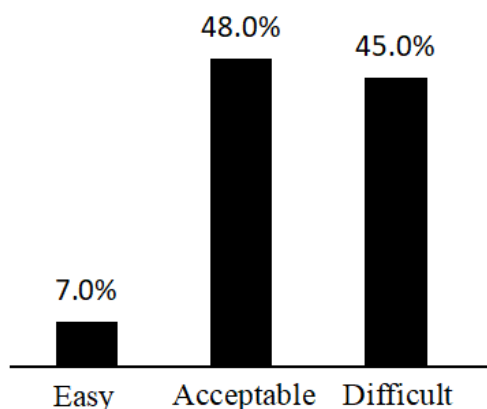


Figure 2 A survey on "difficulty of learning physics" for students of grade 2019 in Materials Major.

Under the background of college enrollment expansion and the further reform of college entrance examination mode, the students in the same class have large individual differences. For example, some students who took physics as elective class in senior high school but didn't participate in physics examination in NCEE are also admitted to science and engineering major. Figure 2 shows the results of a survey on the problem of "difficulty of learning physics" for students of grade 2019 in Material Major. It can be seen that nearly half of the students (45%) think that physics is very difficult, 48% of the students think it is difficult but acceptable, and only 7% think it easy. According to further investigation, in addition to the difficulty of physical theory itself, it has been found that students' response is also largely derived from another important factor: advanced mathematics.

Physics is a subject to study the laws of the objective world quantitatively and accurately and mathematics is the description language of physics. In terms of curriculum, advanced mathematics is a prerequisite course for college physics, which is a good tool to deal with many related physical problems. For Example, calculus and vector analysis are widely used in college physics, which is directly related to students' confidence in learning college physics. Figure 3 shows the students' self-judgment about their advanced mathematics foundation. It can be seen that a few students (16%) think their relevant mathematics knowledge is good, and nearly one third of them think their mathematical foundation is poor. Actually, the situation of college physics teaching in recent years shows that more than half of the students' mathematical foundation is not good enough to support college physics learning. Teachers have to spend some time in reviewing relevant mathematical knowledge constantly, which has been an obvious feature in college physics teaching.

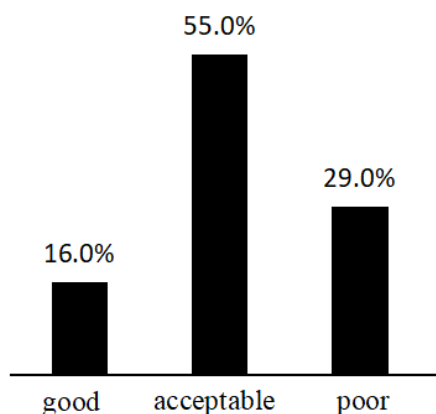


Figure 3 A survey on "foundation of advanced mathematics" for students of grade 2019 in Materials Major.

Our school is a typical engineering-oriented college, which aims at cultivating high-quality application-oriented senior professionals with solid theoretical foundation, excellent practical application ability and strong innovation spirit. The current training programs for undergraduates strengthens the cultivating of students' engineering practice ability, thus the class hours of practice courses are increased appropriately while the class hours of some theory courses are cut. At present, it offers 96 class hours of "college physics I, II" for all engineering majors, which is more than 30 class hours less than the initial 128 class hours. This requires physics teachers to teach mechanics, thermology, optics, electromagnetism and modern physics in a more limited time. If the relationship between class hours and students' learning is not handled well, physical theory will become more boring, which will lead to loss of students' confidence in physics. In addition, for non-physics-majored students of science, they have not formed an overall understanding of the knowledge structure of their major. They are not aware that college physics is an important compulsory course for them. Therefore, in the case of decreasing class hours, the original existing problems of "more difficulty, poor foundation, low interest, more content" will be more serious for students in college physics learning.

The problems mentioned above need every teacher engaged in college physics teaching to explore seriously and seek solutions to solve actively. Fortunately, the rapid development of the information age provides an opportunity for the problems. Especially under the epidemic situation, the profound changes in teaching methods have provided many useful thinking and experience.

### 3. College physics teaching under the background of information

Since the beginning of the 21st century, human beings have stepped into the information age at a very alarming speed. The coming of information age not only changes people's pattern of production and life, but also changes people's way of thinking and learning. Especially, for the front-line teachers who work in the university campus and the students who live and study on the campus, they have personally experienced and even created the changes of education patterns related to information technology.

For college physics, the integration of information technology and the course is a hot spot in the current teaching reform. It is an important issue for college physics teachers to understand the functions and characteristics of information technology in practical teaching, thus to realize the integration of information technology and college physics teaching. According to the problems mentioned above, with the characteristics of the information age, it will be discussed that the direction and concrete implementation of college physics teaching reform from the following three aspects.

#### 3.1. Diversified teaching mode

The information age is an era of knowledge explosion and technical renewal. Especially, technology has advanced at a breathless pace. Many unprecedented online teaching methods and platforms have emerged in the field of teaching, such as MOOC, micro-lectures, tencent classroom, enterprise wechat, rain class, cloud class and so on. These online teaching technologies should be an effective supplement to the traditional teaching mode. Moreover, the popularity of online teaching mode can promote the rapid development and application of information technology. Conversely, the rapid development of information technology can also better support modern education.

In the current environment for the college admission, the individual differences of students are great. How to maintain ecological balance of the classroom teaching is a matter that needs to be considered seriously. Based on the analysis above, college physics has characteristics of short class hours and complicated contents. Consequently, how to arrange teaching schedule and review after class in order to achieve a good teaching effect must be considered fully. In fact, preparation and after-school testing can be implemented through online teaching mode. Before each lecture, teachers can upload some relevant short videos and moderately difficult but enlightening exercises on the online teaching platform for students to prepare for the course. Thus, they will have a certain understanding of the learning content through preview before entering the offline classroom. Then, students are able to form the prediction of the difficulty of the course, so as to transfer the passive learning into the targeted active learning. According to the students' preview in advance, the teacher can receive the information about the learning process of the students, and then adjust the teaching in time. The test after class is an intuitive reflection of students' mastery of knowledge. For the traditional form of homework correcting, teachers not only take a lot of time and effort to collect students' wrong questions, but also limit timely and intuitive information feedback on homework. Online teaching platforms, such as rain class or cloud class, have adopted big data technology. The technology can automatically grade and add scores for multiple-choice items and generate statistical charts reflecting students' mastery of knowledge. It is instructive for teachers to follow up students' learning situation constantly and give targeted guidance timely. For example, for a large proportion of wrong items, teachers can record the corresponding comments and then upload them to the online teaching platform for students' reference. In this way, it can not only help students with different foundation to learn difficult knowledge, but also solve the problem of tense class hours to a certain extent.

Generally speaking, offline teaching method has irreplaceable advantages. For example, it is helpful to achieve face-to-face communication between teachers and students, and teachers can timely get the knowledge of the students so as to adjust the teaching progress at any time. However, the diversified teaching mode, especially the online teaching mode developed in the information age, is definitely a very beneficial supplement to the offline teaching method. It can solve the problems of "poor foundation, more content" in the current college physics teaching.

#### 3.2. Modernization of teaching means

Today's undergraduate were born in the 21st century and grew up in the information age. All kinds of electronic products can be said to be their friends in life. They have no barrier with information technology. Teachers need to improve their own information attainments and show the teaching content with contemporary technology. Thus, the teaching content can keep pace with the times and the teaching

means can resonate with students. Teachers should enrich the teaching form and make college physics course with constant innovation.

Before the information age, the traditional teaching method of "blackboard + chalk" assumed the main function of knowledge transmission. This is a practical and effective traditional teaching method. However, in the process of college physics teaching, there are many abstract physical ideas and principles, which are difficult for students to understand. Using multimedia teaching means, such as playing flash animation, related video materials and demonstrating program simulation, students can feel and understand the abstract concepts, complex theorems and laws from the perspectives of sound, image and programming. It is helpful to present the teaching content in a vivid, intuitive and interesting form. The teaching method combined with information technology can greatly stimulate students' interest in physics learning, thus greatly improving the teaching effect. For example, to distinguish the two similar concepts of impulse and momentum, we can play some related videos, such as the throwing action of javelin athletes or the demonstration experiment of eggs falling into the water. Then teachers put forward questions according to the broadcast content and then introduce the physical concept - impulse, and then momentum theorem. In addition, the formation of physical thought is an important aspect of physics teaching. If the lack of penetration of physical thinking, physics learning will inevitably be obscure. We should pay more attention to the integration of physical thinking into every link of teaching. This can enhance students' interest in physics learning and enable them to think and solve physical problems with physical thinking. For example, students can be instructed to program and simulate some simple physical processes, such as standing wave feather and polarization of light, etc. These programming exercises help students get insights into the essence from the physical phenomenon, and thus cultivate their habit of thinking and innovative thinking ability.

By integrating multimedia teaching, computer programming and other teaching methods with traditional teaching, we can obviously improve the problems of "more difficulty, low interest" in the current college physics teaching. At the same time, it is helpful to cultivate students' observation, innovative thinking, deep thinking and practical ability so as to achieve efficient classroom in the teaching practice.

### ***3.3. Specialization of teaching direction***

Science-and-engineering Students generally have their own distinct characteristics. Most of the undergraduates in our college will take up an occupation after graduation. Most of their occupation fields are closely related to their majors. It can be imagined that students will pay great attention to the accumulation of knowledge and skills related to their major and the practicality of knowledge. However, due to the strong theoretical nature of college physics and the lack of close combination with professional courses, students often feel uninterested in physics. However, it should be important for them to realize that college physics plays a fundamental function in providing basic knowledge for many specialized courses. It is necessary for the students to deeply realized that college physics is closely related to their future work adaptability and development potential. Consequently, it is crucial to analyze the relationship between college physics and professional courses. We can arrange teaching activities that not only can meet the needs of students' knowledge but also integrate students' major with the characteristics of college physics. Therefore, the split between college physics teaching and professional courses should be avoided. Generally speaking, different majors have different needs for physical knowledge. For example, civil engineering and mechanical engineering students require more mechanics knowledge. Computer science and electronic information specialties require more electromagnetism. Energy and power engineering specialty still needs more thermodynamics. Thus, college physics teaching should be adjusted to meet the needs of different professional students for different physical knowledge emphasis, which brings forward the higher request to teachers' knowledge and capacity.

Physics teachers should consciously strengthen the learning of professional knowledge closely related to physics so as to improve their professional ability and knowledge level. Because college physics teachers are generally educated by systematic physics, the knowledge of other professional courses might probably not be enough. The advent of the information age makes the problem no longer complex. In the information age, teaching resources tend to be enriched and shared, which greatly broadens the vision of the teachers. It is very convenient to consult a lot of data through the network or conduct full investigation on different majors. Then the teachers can form a full understanding of the inter disciplines and understand the needs of different engineering majors so as to realize the relevant specialization of relevant chapters of teaching content. At the same time, teachers can also guide students to collect information and inquire about the application of physical knowledge in their major.

The direction of teaching can be adjusted by using the advantages of the information age. The increasingly rich and shareable network resources are able to provide strong support for the adjustment. Under the condition of tense class hours, the specialization of teaching direction can make full use of students' desire for professional knowledge to improve their interest in physics learning. The problem of "low interest, more difficulty" can be solved to a certain extent.

#### 4. Conclusions

The explosion of knowledge and the rapid development of science and technology in the information age put forward higher requirements for talents cultivation. The general applied talents have been difficult to adapt to the development of the times. The cultivation of learning and creative talents has become the core of the future education work. Making full use of information technology is the first step to cultivate new talents.

Based on the analysis of educational environment and the survey of the basic situation of college physics learning, the paper explores how to implement college physics teaching under the background of information age. It can be seen that the development and popularization of information technology has a profound impact on education. At the same time, information technology not only injects new vitality into education, but also puts forward higher requirements for education. Reasonable application of the advantages of the information age can effectively reform the traditional teaching mode, teaching means and teaching direction. It makes the physics teaching process free from the traditional mode which sets "teacher, classroom, textbook" as the three centers. Information technology can improve the quality and innovation ability of students in all aspects, which effectively guarantee the undergraduate education with the characteristics of application-oriented talents.

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