# Innovation and Practice of Higher Education Teaching Models Against the Background of Digital Transformation

## Taking the Course of University Physics as an Example

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**ABSTRACT**

This article introduces the current situation and existing problems of traditional university physics courses. In this context, an innovation and practice of university physics teaching mode under the background of digital transformation have been carried out. This case has significant meaning and reference value for promoting the digital transformation of university physics course continuously. By clarifying the challenges and strategies during the transformation process, it provides beneficial references and guidance for universities and teachers, which helps to improve the quality of university physics teaching and promote the development of students. At the same time, it also provides theoretical support and practical experience for the teaching reform of higher education.

***Keywords:*** *Digital transformation, University Physics, Teaching mode, Teaching reform.*

## 1. INTRODUCTION

With the rapid development of digital technologies such as artificial intelligence, big data and cloud computing, the global education landscape is undergoing radical changes[1]. As the core place for personnel cultivation and scientific innovation, higher education institutions are experiencing structural changes brought about by digital transformation. According to the report by United Nations Educational, Scientific, and Cultural Organization in 2023, 93% of higher education institutions around the world have initiated digital strategies[2]. This education model transformation driven by the digital technology revolution is breaking through the physical boundaries of traditional campuses and reconfiguring traditional modes of teaching, research, and management. The COVID-19 pandemic accelerated and somehow, forced the process of digital transformation of higher education[3][4]. The digitalization of higher education has become an emergency tool. And many online education platforms such as MOOC and virtual simulation experiment technology continue to emerge[5]. Currently, the digital transformation of higher education has evolved from an emergency tool to a strategic choice, aiming to the pursuit of educational values such as promoting educational equity, personalized learning and interdisciplinary collaboration. The digital transformation of higher education not only brings historical opportunities for higher education to break through resource barriers and enhance management efficiency, but also brings new challenges for the transformation of the roles of teachers and students, the improvement of digital literacy, the innovation of teaching models, and the assessment of educational quality.

The University Physics course is a required foundational course for undergraduate students majoring in engineering and science[6]. The course focuses on the study of the structure and interaction of matter, as well as their basic laws of motion. Through the university physics course, students can master the basic concepts and laws, basic theories and basic experimental methods of physics. They can understand the research objects and research methods of physics, cultivate their ability to

analyze and solve problems and improve their scientific literacy[7]. In recent years, our university physics courses have accumulated part of the experience with the goal of strengthening students' thinking ability and innovative practical ability. Taking the digital transformation as an opportunity, we promote the teaching reform continuously. This paper analyzed the digital transformation of the teaching mode of university physics course comprehensively and in-depth. It explored the innovative methods and practical paths of digital transformation in the process of promoting the teaching reform of university physics courses. It summarized the useful experience for the teaching reform of basic courses in science and engineering and provided a reference for the digital transformation of teaching models in higher education at the same time.

## 2. THE CURRENT SITUATION AND EXISTING PROBLEMS OF TRADITIONAL UNIVERSITY PHYSICS COURSES

The traditional teaching mode of university physics courses is centered on the knowledge system of classical physics, covering a wide range of knowledge and difficult. The knowledge transmission is mainly based on one-way indoctrination, and the teaching content emphasizes the theoretical derivation. The experimental part is disconnected from theoretical teaching, and students generally complain that the university physics courses emphasize mathematical algorithms and abstract derivations. So, it results in insufficient understanding of the essence and thinking methods of physics. There is a phenomenon of "separation between learning and application", and students' innovation and practical ability is difficult to effectively cultivate. With the rapid development of science and technology and the profound transformation of educational concepts, the traditional teaching mode of university physics courses has gradually exposed problems that do not match the requirements of personnel cultivation in the new era[8]. Currently, many universities have already innovated and practiced the teaching reform of university physics courses in the light of the current new situation and opportunities. However, they still face some problems and new challenges in actual teaching.

### *2.1 The Students' Basic Knowledge Levels Are Not Uniform*

Under the new college entrance examination system, different provinces have begun to implement reforms of the college entrance examination model such as “3+3” or “3+1+2”[9]. Chinese, Mathematics and English are compulsory subjects, and physics is listed as an optional subject. The reform of the college entrance examination may seem to be a reform in the field of basic education, but its influence is far-reaching. For the field of higher education, these changes have a direct impact on students' subsequent learning in the university stage. Due to the inconsistent progress of college entrance examination reforms in various provinces, the students' basic knowledge levels are not uniform. Students are facing multiple challenges such as differences in basic physical knowledge and inadaptation of learning habits. Knowledge learning has the characteristics of stage and continuity, and learning physics knowledge is also no exception. Only focusing on a certain stage will lead to the phenomenon of knowledge "discontinuity" and reduce learning efficiency. In recent years, our physics teachers have reflected that the teaching pressure is increasing day by day generally. Physics is a public basic course, usually for large classes, involving many students' majors. College students from all over the country have a great difference in their physics backgrounds. They sit in the same classroom and receive the same physics teacher's teaching, which brings great challenges to both the teaching of teachers and the learning of students.

### *2.2 Dull Classroom Atmosphere and Low Student Participation*

The university physics course is a teaching subject that focuses on imparting core knowledge of classical physics theories. It adopts a linear teaching path of "theoretical lecture + formula derivation + confirmatory experiments", which focuses on the elaboration of the physical laws and principles, as well as their applications in technological development. Currently, there are diversified teaching methods in university physics courses. Besides the traditional board teaching and lecture methods, multimedia teaching, question-and-answer teaching, and flipped classroom have been added. However, the application of digital teaching tools mostly stays at the level of PPT presentation, failing to fully apply the advantages of modern technologies such as virtual simulation

technology. The application of online education platform only stays on the surface, and digital teaching resources have not been flexibly utilized.

Today, college students are not merely facing the knowledge in textbooks. With the popularization of electronic devices, a variety of social platforms, short video platforms and video games are attracting students strongly, which are occupying their valuable time.

### *2.3 Poor Coherence Between University Physics and Professional Courses*

In the educational process of Chinese universities, there exists a mindset that values professional knowledge over basic knowledge. Most of the students have cognitive bias for the value of university physics as a public basic course. Some students are reluctant to learn physics knowledge and their motivation for learning physics is weak. Shenyang Pharmaceutical University is a comprehensive pharmaceutical university. Many teachers have indicated that students often ask why they need to learn physics when their major is related to pharmacy during the teaching process. They also asked questions about the role of physics learning. The University Physics course is a compulsory basic course for undergraduate students in science and engineering majors. The effect of physics course learning is related to the students' problem-solving ability and innovation ability in the future. However, from the actual situation, students do not give due attention to the University Physics course. They may think that the contribution of physics courses to professional development is small. The main reason is that the content of the University Physics course is highly systematic and the knowledge framework has been fixed for many years. The University Physics course is not closely connected with students' major courses and it has insufficient relevance with the cutting-edge. Therefore, there is a significant disconnection between the current teaching content of the University Physics course and the needs of interdisciplinary integration in the new era. It is urgent to restructure the teaching content and innovate the teaching paradigm.

### *2.4 Single Method of Evaluating the Course*

The assessment system is a key tool to measure teaching the quality of teaching and learning outcomes. It enables us to understand whether to achieve the expected teaching objectives and achieve the expected learning outcomes. It is a necessary means to guide students to complete learning tasks and test their learning effectiveness. It is also an important guarantee for the construction of the course[10]. Currently, the assessment mode of university physics courses consists of final exam scores and process scores. And the final exam scores are given more weight. Most teachers rely on the paper scores to test students' mastery of university physics knowledge. This assessment method of students' learning is one-sided, which leads to some students having poor learning initiative. They only do practice exercises before exams and pass the exams through simple rote memorization. This is very detrimental to students' development. And it reduced the correlation between academic performance, learning process and ability level which in turn leads to inaccurate assessment.

## 3. DIGITAL TRANSFORMATION PRACTICES FOR UNIVERSITY PHYSICS COURSES

### *3.1 Digitization of Teaching Resources to Build a Multi-dimensional and Three-dimensional Knowledge System*

#### *3.1.1 Digital Transformation of Textbooks*

The rapid development and popularization of science and technology has accelerated the process of digital transformation in education. During the digital transformation process of education, it is required that textbooks also adapt to the development of the times. Therefore, the digital transformation of textbooks is an inevitable trend. The digital transformation of textbooks is the backbone of the construction of digital educational resources. The digital transformation of textbooks is not limited to the transformation of the form of textbooks, it is a multifaceted educational reform measure, including the presentation of textbooks and the transformation of teaching methods. Therefore, in the process of preparing textbooks, it is no longer limited to the traditional form of textbooks, but new forms and three-dimensional textbooks have been prepared. We participated in the production of digital resources for the National Health Commission's “14th Five-Year Plan” textbook “Physics” (8th edition) published by the People's Health Publishing House. We recorded micro-videos for the experiments involved in

different chapters to assist classroom teaching. And we wrote the "Basic Physics" textbook published by the Medicine Science and Technology Press of China. Relying on the online learning platform, we constructed a new type of textbooks that cover paper textbooks, digital resources, and platform functions.

### *3.1.2 Digital Transformation of Course Resources*

Digitalized course resources are an important support for the digital transformation of teaching models[11]. Digitalized course resources can be presented in various ways such as micro-videos, knowledge graph, PPT and question banks. They can assist teachers in implementing digitalized classroom teaching and provide corresponding information, technology and environmental support for students' learning. During the construction of digitalized course resources, we use cartoon digital human images to produce micro-videos and incorporate cutting-edge technologies and ideological and political elements related to university physics courses. Micro-videos can be used in the pre-class preview stage and the classroom introduction stage for students. This new type of video presentation can stimulate students' interest in learning, better realize the interaction between teachers and students and improve learning outcomes. In addition, some intelligent teaching platforms can automatically sort out knowledge points and generate knowledge graph after teachers upload course resources to help students master the knowledge structure of the course quickly. In terms of teaching design, the auxiliary lesson preparation mode in intelligent teaching platforms can help teachers prepare lesson plans, design PPTs and provide teaching cases. Meanwhile, AI can be used to generate questions to add online tests and discussion topics. It can guide students to participate in classroom interaction actively, consolidate what they have learned promptly, and improve learning outcomes.

### *3.1.3 Application of Virtual Simulation Experiment System*

One of the most important teaching goals of the university physics course is to cultivate students' abilities of analyzing problems and solving problems. Therefore, experiments are often used to verify the basic principles of physics in university physics. However, in the actual course arrangement, students have fewer opportunities to operate the experimental equipment themselves. To solve this problem, we utilize the virtual simulation experiment teaching platform. It can reduce the cost of experiments, enable students to operate actively and gain a direct understanding of the experiments. And it realizes the transformation of the main body from teachers to students. It is also convenient for review and exploration of innovative experiments, fully stimulating students' interest in learning.

## ***3.2 Digitalization of the Teaching Process to Create a New Paradigm of Intelligent Teaching***

### *3.2.1 Innovation in Hybrid Teaching Model*

By adopting smart teaching platforms, we have initiated a hybrid teaching model to achieve the organic connection of knowledge transmission before class, in-depth exploration during class and consolidation and expansion after class. As of January 2025, more than 1,300 students from our university have joined the University Physics course in Superstar Learn Platform for eight consecutive semesters. During the teaching process, teachers preset digital teaching resources on the platform in advance. And students can preview independently before class and complete the online course task points to achieve pre-class guidance. During the learning process, students can utilize the functions of AI video interpretation and question explanations to achieve autonomous learning. At the same time, the data provided by the platform can reflect students' preview situations, and teachers can adjust the teaching focus at any time. During the teaching process, the intelligent teaching platform is utilized to release teaching activities such as sign-in, discussion, quiz and test, which improves student participation, saves time and enhances teaching efficiency. After class, students can expand and summarize their knowledge points through the knowledge graph and consolidate knowledge through the online question bank. Teachers can use the platform to review homework by AI, analyze the learning situations and adjust the content of subsequent course in real time. Through this hybrid teaching model, teachers and students can connect the teaching and learning before, during and after class. It can break the barriers in time and space between teachers and students and help to improving teaching quality.

### *3.2.2 Learning Behavior Monitoring and Data Statistical Analysis*

With the help of intelligent teaching platforms, the login time and frequency of students can be recorded precisely. Teachers can understand the frequency and approximate time periods of students' participation in online course learning. In addition, through the statistics of course browsing duration and chapter learning progress provided by the platform, teachers can grasp the time students have invested in different course contents and their completion degree. By using the AI learning analysis tool, teachers can obtain students' participation in courses, such as their speeches, discussions and homework submissions. At the same time, by comparing students' learning data at different stages, teachers can understand the changing trends of students' learning status, which is conducive to teaching implementation. Moreover, the intelligent teaching platform can provide teaching suggestions based on the monitoring and analysis results of learning behaviors. It can help teachers identify students' questions in learning, optimize teaching content and provide personalized tutoring for students.

### *3.2.3 Digitalization of Teaching Assessment to Establish a Full-cycle Assessment System*

The single assessment method based on the final exam results is difficult to comprehensively reflect the learning process of students and the teaching effect of teachers. The feedback of assessment results is not timely, so it is impossible to adjust teaching strategies in a timely manner, which is not conducive to the improvement of learning quality and teaching quality. With the increasingly abundant digital teaching resources and the wide application of online teaching platforms, teaching assessment also needs to keep up with the times and achieve digital transformation[12]. By intelligent teaching platform, we have carried out the practice of digital teaching assessment, established a full-cycle assessment system and carried out comprehensive and systematic assessment throughout the entire process. The final assessment result of university physics consists of process assessment and result assessment. Firstly, for process assessment, we rely on the intelligent teaching platform to integrate the classroom interaction data and post-class task feedback data in the statistics platform, it can collect multi-dimensional data such as students' preparation, class participation, homework completion and project practice in real time. We form a digital archive covering “Goal setting - Process tracking - Result assessment”. Through statistical analysis of learning behavior data, we can adjust teaching strategies in a timely manner and provide personalized tutoring to achieve the closed-loop management of “assessment - feedback – optimization”. Secondly, for result assessment, we collected questions from classic textbooks, past exam papers and other reference materials. And we built a content question bank combined with AI question generation to ensure the diversity and representativeness of the questions. At the same time, we use the intelligent teaching platform to enter and classify the questions, and organize and release them at any time for final exam. It can realize statistics of students' scores and grades and improve the efficiency and quality of the examination.

## 4. EFFECTIVENESS OF DIGITAL TRANSFORMATION IN UNIVERSITY PHYSICS COURSES

### *4.1 Improvement of Students' Learning Effectiveness*

Through the questionnaire survey and classroom observations, it was found that students' interest in learning the university physics has significantly increased. (“Figure 1”) The digital teaching model has abundant teaching resources and innovative teaching methods, which attracted students' attention and enhanced their learning enthusiasm. The participation of students in class has also improved significantly. More students answered questions actively, participated in discussions and expressing their opinions. The digital teaching model provides students with more opportunities for independent learning. Students can learn independently on the intelligent teaching platform according to their own learning progress and needs. And they can develop good independent learning habits gradually. By analyzing students' learning records and homework completion, it was found that students can complete learning tasks independently and explore knowledge actively. All this shows that the digital teaching mode helps students master knowledge better and improve their learning performance.

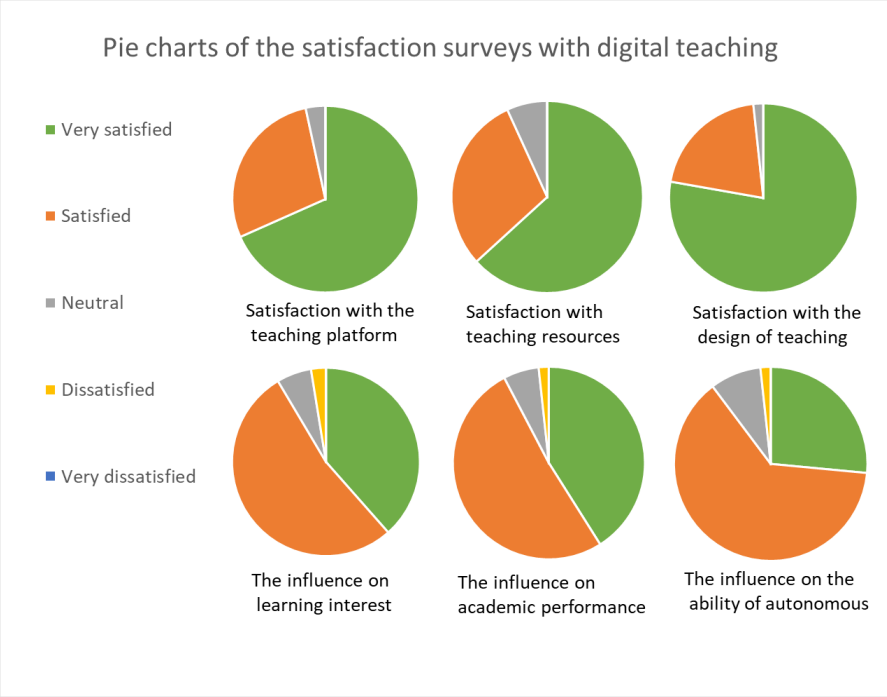


Figure 1 Pie charts of the satisfaction surveys with digital teaching.

### *4.2 Improvement of Teaching Quality*

By collecting the feedback and evaluation data from students regarding the teaching of the university physics course, it was found that students were highly satisfied with the teaching quality of this course. Students thought that the digital teaching resources have enriched the teaching content and the teaching methods have become more flexible and diverse, which can better meet their learning needs. Meanwhile, during the implementation of digital teaching, teachers continuously optimize and adjust the teaching process through the analysis of teaching data and students' feedback. The optimization and adjustment of the teaching process enhanced the effectiveness of teaching. Through the assessment of the achievement of teaching objectives, it was found that the achievement rate of teaching objectives is high after the implementation of digital teaching. (“Figure 2”) Students have been better developed in terms of knowledge and ability. They have mastered the basic concepts, principles and methods of university physics. And they got scientific thinking and innovation abilities, and had the ability to solve practical problems using physical knowledge.

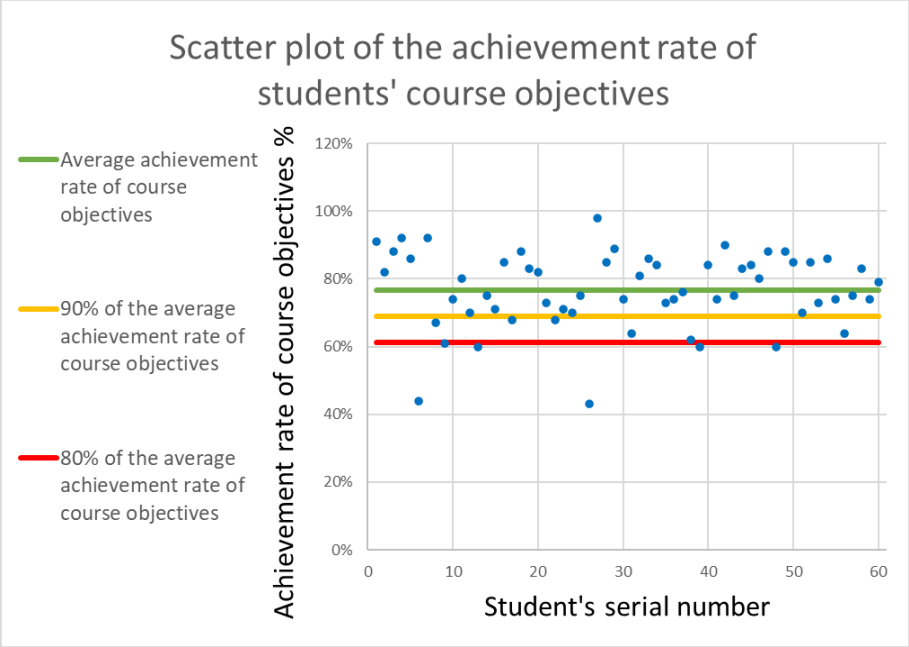


Figure 2 The average achievement rate of course objectives.

### *4.3 Improvement of Students' Comprehensive Abilities*

Digital teaching provides students with more opportunities to learn the cutting-edge technology and innovative practices. Through micro-videos and case analyses of the cutting-edge technology in digital teaching resources, students' innovation of science and technology have been cultivated. Some students participated in innovation and entrepreneurship competitions under the guidance of their teachers and achieved certain results, and their innovation ability was significantly improved. Through the application of digital teaching resources and virtual experiments, students can understand the application of physical knowledge in real life more intuitively. It can help them master the methods and skills for solving physical problems better. During the actual teaching process, students can apply the physical knowledge they have learned to solve some practical problems, and their comprehensive abilities have been improved.

## 5. CHALLENGES AND STRATEGIES OF UNIVERSITY PHYSICS COURSES UNDER THE BACKGROUND OF DIGITAL TRANSFORMATION

On the whole, the digital transformation of university physics courses is still in the infancy stage. It faces numerous challenges in terms of technology application, teaching, learning and management. For a long time, traditional teaching concepts have been deeply rooted in the minds of teachers. They are accustomed to the teaching model centered on themselves and need to adapt to the student-centered teaching model gradually. Moreover, some university physics teachers lack systematic digital teaching training and are not proficient in mastering digital teaching tools and technologies to give full play to the advantages of digital teaching. Teachers also face some challenges in innovation of teaching design and methods. The digital teaching mode and the physics knowledge need to be integrated organically. The university physics course has a certain degree of difficulty. So, students need to have strong independent learning abilities during the digital transformation process. However, there are large differences in the independent learning abilities of different students. Some students can utilize digital teaching resources for learning, formulate reasonable learning plans, while others lack independent learning abilities and methods, and rely on the guidance of teachers.

In response to the above challenges, universities, teachers and students should always maintain the concept of lifelong learning and promote the digital transformation of education continuously during the process of digital transformation of university physics course. First of all, teachers need to maintain communication with technicians of online education platforms, integrate and screen the

existing digital educational resources to improve the quality of resources. In addition, universities should organize teachers to participate in digital teaching training regularly, which includes the use of digital teaching tools and technologies, teaching design and innovation of teaching methods. At the same time, experts can be invited for lectures and guidance to share advanced teaching experiences and cases. Finally, teachers should pay more attention to cultivating students' independent learning ability during teaching, guiding students to formulate reasonable learning plans and master effective learning methods. The university and teachers should provide guidance for students' digital resource learning. It is necessary to help them familiarize themselves with the operation and usage methods of teaching platforms, and improve their ability to access and utilize learning resources.

## 6. CONCLUSION

In the future, the digital transformation of university physics courses will develop in a direction that is more intelligent, personalized and internationalized. Technologies such as artificial intelligence and big data will be applied in teaching more widely to achieve intelligent management and personalized services in the teaching process[13]. At the same time, with the strengthening of international exchanges and cooperation, digital teaching resources will be more diverse, and students will have more opportunities to learn international advanced physics teaching concepts and methods. Future research can further explore the in-depth integration of digital teaching technologies and university physics teaching. We can develop more suitable digital tools and resources for physics teaching. At the same time, it is possible to strengthen the long-term tracking and evaluation of the effectiveness of digital teaching, and study how to promote students' learning and development better.

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