International Education and Culture Studies
ISSN 2766-6778
Vol. 3, No. 4, 2023
Published by STSL Press

*Original Paper*

# Reform and Practice of the Life-oriented Teaching of College Physics

Tingting Liu[1] & Haibin Sun[1]

[1] College of Physics and Electronic Engineering, Taishan University, Tai'an, Shandong, 271000, China

Correspondence: Tingting Liu, College of Physics and Electronic Engineering, Taishan University, Tai'an, Shandong, China. E-mail:.liuttphy@tsu.edu.cn

**Abstract**

Physics is concerned with the basic principles of the universe. College physics is mainly based on the fundamentals of physics, is a compulsory course for non-physics majors of science and engineering in colleges. College physics play a crucial role in studying subsequent professional courses. In recent years, college physics teaching in China has witnessed remarkable advancements, but some problems have remained. The reform of college physics courses advocates that teaching should return to life, and physics knowledge should be used to solve problems in life. The life-oriented teaching of college physics connects the content of classroom teaching with life experiences and practices, which can stimulate college students' interest in learning physics and promote their physics learning outcomes.

**Keywords:** life-oriented teaching, college physics, teaching reform

## 1. Introduction

Physics is the natural science that studies the basic structures, forms of motion, interactions, and the laws of transformation of matter. Physics presents a series of scientific worldviews and methodologies that have profoundly influenced mankind's basic understanding of the material world, way of thinking, and social life, and constitutes the cornerstone of the development of human civilization. With its profound historical background, scientific spirit of seeking truth from facts, insightful scientific thinking, dialectical materialist research methods, subtle humanistic values, and fundamental role in leading science and technology, Physics has provided college courses with rich and colorful educational and teaching resources and forged their distinctive features (Lü & Yu, 2021; Lin et al., 2023).

The "College Physics" course, which is mainly based on the fundamentals of physics, is a compulsory course for non-physics majors of science and engineering in colleges; it serves as a professional foundation course for undergraduate majors in subjects such as electronic information science and technology and chemistry (Getty, Gosnell, Whitten, & Taylor, 2020; Zhang et al., 2021). College physics mainly includes the basic knowledge, basic methods, and laws of physics related to mechanics, thermodynamics, electromagnetism, optics, atomic physics, quantum mechanics, and so on. From the macroscopic, mesoscopic, to microscopic, as large as stars, space stations, spacecraft, and as small as atoms, molecules, and quarks. Modern science, technology, production, and life rely on the knowledge of physics (Jusup et al., 2022; Sinatra, Deville, Szell, Wang, & Barabási, 2015). College physics courses not only lay the necessary knowledge foundation for students to study subsequent professional courses, but also play a vital role in cultivating students' scientific literacy and innovative consciousness and improving their ability to analyze and solve problems (Rieger, McIver, Mazabel, & Burkholder, 2023; Y. Wang et al., 2020; White Brahmia et al., 2021; Zalewski, Novak, & Carlson, 2019).

As one of the courses required for non-physics majors in science and engineering, college physics play a crucial role in studying subsequent professional courses. In recent years, teaching physics for non-physics majors in China has witnessed remarkable advancements, but some problems have

remained, mainly in the following aspects (Feng, Li, Cheng, & Yun, 2022; LV, 2021; Zhang et al., 2021).

(1) Students' fundamental knowledge in physics is not uniform. China's high school physics curriculum is divided into compulsory modules, optional compulsory modules, and elective modules, and students learn different physics modules in high school. In line with the reform of the college entrance examination model, some high school students do not learn physics when they choose their courses, which renders some high school graduates' mastery of physics incomplete, resulting in uneven knowledge and evident gaps in their physics foundation when they learning college physics.

(2) The professional pertinence of college physics teaching is not good. Currently, college physics courses for science and engineering majors in China have between 3 and 5 credit hours. Compared with the physics covered by college physics courses, these credit hours are relatively low. In college physics teaching, the teaching content of different majors and difficulty level are determined by credit hours, rather than the knowledge acquisition needs of the majors studied by undergraduates.

(3) The content of teaching materials is not updated in a timely manner. The content of college physics textbooks is mainly based on classical physics, involving less modern physics and being unable to reflect the progress and application of contemporary physics theories and experimental techniques in a timely manner.

(4) Students do not pay enough attention to learn college physics. Undergraduates enrolled in non-physics major subjects tend to think that college physics is not their major, and that college physics will not help their professional studies and is irrelevant to postgraduate entrance exams. Hence, undergraduates often do not pay enough attention during the learning process and are not motivated to learn.

(5) Teachers emphasize teaching over learning in the teaching process and lack innovation in their teaching methods and means. Due to the heavy scientific research tasks of the lecturers, they often do not invest enough time in teaching and preparing for classes. There remains a traditional passive teaching style with cramming and spoon-feeding in the classroom teaching of college physics. It is a teacher-oriented and receptive learning process, with students mainly learning textbook knowledge with few classroom demonstration experiments, which leads to the lack of interest and enthusiasm for active learning in students.

(6) The assessment method and evaluation criteria are singular. The assessment method lacks relevance, which generally consists of two parts: usual grades and the test grade, with the usual grade composed of attendance and regular homework. There is a clear disconnection between the assessment content and the course objectives, which cannot reflect the effective combination of theoretical and professional knowledge of physics and cannot provide a comprehensive evaluation of students' scientific thinking and innovation ability.

Considering the above problems in college physics teaching, we designed a life-oriented education model of college physics based on the theory of life-oriented education in teaching to enhance the vitality of classroom teaching in college physics and promote the improvement of classroom teaching quality. The results of teaching practice show that life-oriented teaching of college physics can stimulate students' enthusiasm for learning and improve their academic performance significantly.

## 2. Literature Review

John Dewey (1859-1952) was an American philosopher, psychologist, and educational reformer whose ideas have been influential in education and social reform (Moyer, 1982). Dewey founded the ideological system of pragmatism education. He believes that "all genuine learning comes about through experience". Form the points of Dewey experience is not only the means of education, but also the purpose of education; Education is not preparing for life, but life itself (Ansbacher, 2000). According to Dewey's view (Thomassen & Jørgensen, 2020), experience is considered as an active life and an act of trading with the world, and its way is that individuals experience the consequences of their actions. Experience is both undergoing (passive) and trying (active). Through living and experiencing this collective world, language, meaning, practice and identity are translated and updated

to adapt to the new situation. Experience arises spontaneously in the life and actions in a specific place, and education plays an important role in the spread of habits, languages, beliefs, values and traditions and the social continuity of life. According to Dewey, the basic principles of education are (ÖZKAN, 2020): (1) The thought of the expression and development of individuality. (2) Freedom of movement. (3) Learning through experiences. (4) In achieving the goals; learning abstracted skills and techniques as a tool. (5) The idea of making the most of the possibilities offered by daily life. (6) The idea of following the changes in the world against stationary goals and equipment.

From 1919 to 1921, John Dewey traveled extensively in China and lectured on social and political philosophy, philosophy of education, ethics, and the main trends of modern education (Su, 1995). Tao Xingzhi (1891-1946) is a famous educator in the history of modern education in China. He inherited and developed Dewey's educational thought. From the perspective of Tao's theory of life education, life education originates from, and is rooted in life, and life revolves around the theme of education. He advocated and emphasized life by education, education through life, and education for life. With the aim of living a better life as the basic value of education, educational policies, structures, contents, processes, technologies, or methods should be grounded on human development and satisfy people's desire for a better life. This is the true meaning of Tao Xingzhi's life education theory (Wang, Wang, & Ye, 2020).

Dewey believes that educational goals can be achieved through experience. He stated that education is a process of "development within, by, and for experience" (ÖZKAN, 2020). From the point view of pragmatism, Dewey put forward "instrumentalism" for physics teaching. Focusing on the concept of "scientific laws," he explains that these are not ultimate metaphysical truths. On the contrary, laws are merely man-made, intellectual instruments, meaningful only to the extent that they provide the useful consequence of ordering experience(Moyer, 1982).

The reform of college physics courses advocates that teaching should return to life, and physics knowledge should be used to solve problems in life, which is the starting point of education. This aligns with Dewey and Tao Xingzhi's theory.

The theoretical and practical characteristics of college physics are clearer. The life-oriented teaching of college physics means that teachers organically integrate life phenomena with physics knowledge based on students' life experiences, flexibly apply many elements such as life cases, phenomena, and rules to physics knowledge, and construct a life situation that incorporates physics knowledge. Teaching design is determined based on the analysis of academic circumstances and teaching materials, followed by the formulation of scientific and reasonable teaching strategies.

The life-oriented teaching of college physics connects the content of classroom teaching with daily life experiences, concretizes abstract knowledge, popularizes obscure knowledge, and transforms two-dimensional knowledge into three-dimensional knowledge to promote the development of students' scientific thinking, observation, and experimental and innovation abilities. Teachers can skillfully use life-oriented teaching methods in daily teaching to mobilize students' learning enthusiasm, enhance students' ability to solve practical problems, and improve the teaching outcomes of college physics.

## 3. Reform and Practice of Life-oriented Teaching of College Physics

### *3.1 Revise the Teaching Objectives of College Physics with the Concept of Life-oriented Teaching*

The objectives of studying the "College Physics" course include cultivating students' exploration, innovation spirit, scientific thinking ability, and a correct worldview and outlook on life, as well as realizing the coordinated development of students' knowledge, ability, and quality, thereby laying the foundation for studying subsequent courses and professional training. The three-dimensional teaching objectives of college physics courses are as follows:

(1) Knowledge objectives. Students should master the basic concepts and laws of physics, know the scope of applying the basic theories of physics, and understand the application of physical knowledge in production technology, which will lay the foundation for acquiring professional knowledge and participating in practical engineering cases. The students should also be able to describe scientific problems with language and methods based on physics.

(2) Ability goals. Students should build physics models based on situations involving physics; analyze and solve problems by using physics theories and research methods; and possess basic experimental skills, correctly use basic experimental instruments in physics, and correctly process experimental data and write standardized experimental reports.

(3) Literacy goals. Students should appreciate the scientific beauty of physics, understand the scientific nature of physics, and make correct value judgments on social topics involving physics knowledge.

*3.2 Design Life-oriented College Physics Knowledge Modules to Stimulate Students' Interest in Learning Physics*

Based on the three-dimensional physics course objectives of "knowledge and skills, process and methods, and emotional attitude and values," we collected data on and uncovered life-oriented physics resources with contemporary and local characteristics that are closely related to modern life and technology. After sorting them into different categories, we integrated them into the teaching content of college physics. A life-oriented physics teaching resource library (including teaching cases, teaching courseware, experiment guides, teaching videos, teaching pictures, and demonstration animations) comprising the six modules of mechanics, heat, acoustics, optics, electromagnetism, and atomic physics was then established. Based on the characteristics of physics in each module, the six modules were categorized as follows: moving mechanics, intoxicating acoustics, touching heat, fascinating optics, helpful electromagnetism, and amazing atomic physics. Table 1 lists the life-oriented teaching resources of "Moving Mechanics." Figure 1 is pictures closely related to students' life, which is used in the teaching "System of Forces".

Bringing physics knowledge to life and integrating it into classroom teaching can create vivid and life-oriented situations, so that students can be familiar with the latest developments in the field and maintain a positive mental state while learning physics.

Table 1. Life-oriented teaching resources of "Moving Mechanics"

| Chapter | Knowledge Points | Life Phenomenon |
|---|---|---|
| Mechanical movement | Movement and stillness, the speed of movement, the average speed | The fast running cheetah, slow snails, celestial movement, the speed of the car, the speed of the athletes |
| Force and motion | Force and its effect, elasticity, gravity, balance of two forces, friction, Newton's first law, inertia | The shape of the spring bow changes, the ripe apple falls to the ground, and the safety belt. |
| Mechanical energy | Kinetic energy, potential energy, mechanical energy and their transformation, wind energy. | Bullets break through obstacles, rockets are launched into the air, dams are blocked by rivers, platform competitions in the Winter Olympics |

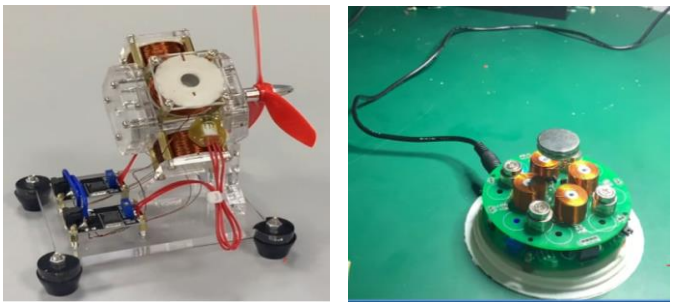
Figure 1. Life-oriented teaching resources of system of forces

*3.3 Develop and Design life-oriented Physics Experiments to Cultivate Students' Practical Skills*

Physics is based on experiments, and therefore, the teaching of college physics requires students to not only fully grasp the theoretical knowledge covered in textbooks, but also learn through hands-on training using experiments to understand the application of physics knowledge in daily life.

In the process of teaching experiments in college physics, we expand the experimental content that is closely relevant to life, introduce life into the exploratory activities of physics experiments, develop and design physics experimental projects based on life experiences, and guide students to use physics knowledge to observe, analyze, and solve problems in daily life. The life-oriented expansion of content can be performed on the examples in the teaching materials, pictures, "think and practice" sections, the scientific world section at the back of the book, and other related physics examples. The details provided in the examples can be improved to include their application in life and get closer to physics in life, and life-oriented examples can also be added. The life-oriented physics experimental projects that we have developed include a car with wireless charging and capacitor, ultrasonic radar, an Arduino intelligent fire extinguishing fan, automatic fire extinguishing robot, visible optical communication technology, ultrasonic intelligent ranging fan, etc.

Relying on the physics laboratory, we set up the innovation center of undergraduates' physics. The center have planned, organized and carried out a series of physics science and technology innovation activities. The proposition of innovative production after class in physics comes from the topic that the physics teacher gives and the topic that the students are interested in. According to their own physics knowledge, combined with access to relevant physics data, undergraduates design and make some works that work by using physical principles, and demonstrate and verify some physical phenomena and laws. Figure 2 is the physics experimental instruments developed and designed by undergraduates under the guidance of teachers.



(a) Hall Electricmachinery (b) Magnetic suspension demonstrator

Figure 2. Physics experimental instruments developed and designed by undergraduates

### *3.4 Innovative Teaching Methods of College Physics*

First, practical activities in physics (science and technology) can be performed to cultivate students' creativity. In the process of implementing the established teaching materials, a variety of extra-curricular activities can be flexibly adopted, such as combining the content of the teaching materials, carrying out innovative small designs, experiments, and productions, and writing small scientific and technological papers in stages based on the actual situation of the school; holding lectures on popular science knowledge; watching films on science and technology to broaden students' horizons; carrying out social practice activities, such as leaving the school environment for on-site investigations; and understanding the application of science and technology in the production of various products. Students participate in all kinds of scientific and technological activities after class, and in this process, they experience the process from imitation to innovation. In this process, students can actively observe life, think about physics knowledge in life, and find its application in life. This not only consolidates physics knowledge, but also sublimates it, which cultivates students' innovative spirit and scientific practical ability and improves their subject literacy. Hence, this effectively cultivates students' divergent and multi-directional thinking ability while stimulating their creativity.

Second, practical assignments should be designed. We transform tedious knowledge in college physics assignments into problems that are closely related to life, and design practical assignments around these problems. As an important form of extra-curricular work, practical assignments break barriers between the inside and outside of the classroom, guiding students to experience knowledge first-hand and understand that knowledge originates from life and can be scientifically applied in life. This further helps students form and build their system of physics knowledge to improve their physics thinking and comprehensive application skills.

Reforming the practical teaching of college physics can enable students to realize the relationship between physics and life, stimulate students' interest in learning physics, make them willing to independently participate in practical science and technology activities in physics, and verify their theoretical knowledge acquired in class. Consequently, it helps students develop good study habits and lay a robust foundation for learning physics in the future.

### *3.5 Achievements of Teaching Reform*

We guided undergraduates to participate in the Shandong Undergraduate Physics Tournament, the Shandong Undergraduate Physics Experiment Tournament, and the Shandong Innovation Tournament of Undergraduate physics, and achieved excellent results. In the preparation stage of the competition, undergraduates' independent creation is the main way, supplemented by teachers' guidance, which is related to the problem. The principle and experimental scheme are independently inquired and designed by students. Students carry out practical research according to the physics principles they have learned, design experiments by themselves, verify physical phenomena and laws, consolidate the physics knowledge they have learned, stimulate undergraduates' interest in physics learning, cultivate undergraduates' team cooperation and cooperation spirit, and exercise their practical ability and scientific and technological innovation ability. Figure 3 is the certificates of award of undergraduates.


Figure 3. Undergraduates' certificates of award

In the first semester of the academic year 2022-2023, we carried out the teaching reform in the college physics teaching of the artificial intelligence undergraduate major of grade 2021. There were 39 students, and the distribution of the final evaluation results is shown in Table 2. The average score of the final evaluation of college physics is 81.97, and the standard deviation is 8.46, the highest score is 94 and the lowest score is 47. This shows that the implementation of life-oriented physics teaching reform has promoted the improvement of students ' academic achievement.

Table 2. College Physics Scores of Artificial Intelligence Undergraduate Major

| Score Section | 100-90 | 90-80 | 80-70 | 70-60 | 60-0 |
|---|---|---|---|---|---|
| Total | 7 | 19 | 12 | 0 | 1 |
| Percentage | 17.95 | 48.72 | 30.77 | 0 | 2.56 |

## 4. Conclusion

The purpose of teaching life-oriented college physics is to make abstract physics teaching more vivid and intuitive and relate closely with students' life experiences and practices, which can stimulate college students' interest in learning physics and promote their physics learning. Therefore, teaching life-oriented college physics is different from teaching life superficially and simplistically, and it is not simply a list of examples about life. Teachers should start from the essence of physics to develop and design life-oriented teaching courses of college physics and identify its core elements. Teachers must first learn to observe and understand life from the perspective of course design and development. Through teaching, they should enable students to learn to actively exercise their knowledge of physics in life, and apply it to analyze and solve practical problems in life.

## Acknowledgments

This work has been supported by the Teaching Reform Project of Taishan University (29) and the First-class Courses in Taishan University (quantum mechanics and theoretical mechanics).

## References

Ansbacher, Ted. (2000). An interview with John Dewey on science education. *The Physics Teacher, 38*(4), 224-227. https://doi.org/ 10.1119/1.880512

Feng, Hao, Li, Changwei, Cheng, Yongcong, & Yun, Bojin. (2022). Exploration on the Problem-oriented Mixed Teaching Mode of College Physics Course. *Journal of Higher Education, 8*(30), 125-128. https://doi.org/ 10.19980/j.CN23-1593/G4.2022.30.031 (In Chinese)

Getty, Stephen, Gosnell, Natalie, Whitten, Barbara, & Taylor, Joseph. (2020). Supporting Inclusive Teaching in Introductory College Physics. *The Physics Teacher, 58*(5), 312-315. https://doi.org/ 10.1119/1.5145523

Jusup, Marko, Holme, Petter, Kanazawa, Kiyoshi, Takayasu, Misako, Romić, Ivan, Wang, Zhen, Perc, Matjaž. (2022). Social physics. *Physics Reports, 948*, 1-148. https://doi.org/10.1016/j.physrep.2021.10.005

Lü, Suye, & Yu, Ge. (2021). On the Teaching Reform of College Physics in the Information Age. *Frontiers in Educational Research, 4*(1), 70-75. https://doi.org/10.25236/FER.2021.040115

Lin, Jiabei, Xing, Yuting, Hu, Yudi, Zhang, Jian, Bao, Lei, Luo, Kaiqing, Xiao, Yang. (2023). Inhibitory control involvement in overcoming the position-velocity indiscrimination misconception among college physics majors. *Physical Review Physics Education Research, 19*(1),010112. https://doi.org/ 10.1103/PhysRevPhysEducRes.19.010112

LV, Shuchen. (2021). Practice and Exploration of College Physics Teaching Reform in Biology Majors. *Physics and engineering, 31*(6), 57-62. (In Chinese)

Moyer, Albert E. (1982). John Dewey on physics teaching. *The Physics Teacher, 20*(3), 173-175. https://doi.org/ 10.1119/1.2340987

ÖZKAN, Umut Birkan. (2020). Chapter 2 Curriculum Development Model of John Dewey. In A. Doğanay & M. O. Kutlu (Eds.), *Current Researches in Educational Sciences* (pp. 23-38). Ankara: Akademisyen A.Ş.

Rieger, Georg W., McIver, Jess, Mazabel, Silvia, & Burkholder, Eric W. (2023). Supporting Students' Self-Regulated Learning in an Introductory Physics Course. *The Physics Teacher, 61*(1), 18-21. https://doi.org/ 10.1119/5.0062172

Sinatra, Roberta, Deville, Pierre, Szell, Michael, Wang, Dashun, & Barabási, Albert-László. (2015). A century of physics. *Nature Physics, 11*(10), 791-796. https://doi.org/10.1038/nphys3494

Su, Zhixin. (1995). A Critical Evaluation of John Dewey's Influence on Chinese Education. *American Journal of Education, 103*(3), 302-325. https://doi.org/10.1086/444103

Thomassen, Anja Overgaard, & Jørgensen, Kenneth Mølbjerg. (2020). John Dewey and continuing management education: problem-based learning for organizational sustainability. *Journal of Workplace Learning, 33*(3), 229-242. https://doi.org/ 10.1108/jwl-05-2020-0080

Wang, Guoyan, Wang, Lingfei, & Ye, Zi. (2020). Tao Xingzhi and the 'marrying science with the public' movement in China. *International Journal of Science Education, Part B, 10*(2), 127-132. https://doi.org/ 10.1080/21548455.2020.1719292

Wang, Yahong, Wang, Lin, Liang, Hongwei, Zollman, Dean, Zhao, Lulu, & Huang, Yan. (2020). Research on the small private online course (SPOC) teaching model incorporating the just-in-time teaching (JiTT) method based on mobile Internet for learning college physics. *European Journal of Physics, 41*(3), 035701. https://doi.org/ 10.1088/1361-6404/ab6c6c

White Brahmia, Suzanne, Olsho, Alexis, Smith, Trevor I., Boudreaux, Andrew, Eaton, Philip, & Zimmerman, Charlotte. (2021). Physics Inventory of Quantitative Literacy: A tool for assessing mathematical reasoning in introductory physics. *Physical Review Physics Education Research, 17*(2), 020129. https://doi.org/ 10.1103/PhysRevPhysEducRes.17.020129

Zalewski, Novak, & Carlson. (2019). An Overview of Teaching Physics for Undergraduates in Engineering Environments. *Education Sciences, 9*(4), 278. https://doi.org/10.3390/educsci9040278

Zhang, Xiuping, Qu, Fengcheng, Chen, Jiaming, Yang, Decheng, Gao, Fan, & Ning, Yanan. (2021). Research on College Physics Online Teaching System Based on Course Group Construction. *Journal of Physics: Conference Series, 1744*(4), 042039. https://doi.org/ 10.1088/1742-6596/1744/4/042039