

The Cultivation and Practice of College Students' Innovation and Entrepreneurship Ability in the Perspective of College Physics

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Abstract: Innovation has become the basic driving force of economic growth and social development, and has been the key factor to maintain and improve the long-term competitiveness of the country. Innovation needs innovative talents, and colleges and universities should make due contributions to the cultivation of innovative talents with innovative thinking and ability. The cultivation of innovative thinking and ability of college students is a systematic project, which requires multidisciplinary integration. As a public basic course in colleges and universities, college physics can not only expand teaching time and space through online and offline combination, but also help guide students to learn independently, develop innovative thinking quality and scientific practice ability. College physics can play an important role in promoting the cultivation system of college students' innovation and entrepreneurship ability.

1. Introduction

At the 20th National Congress in 2022, it was emphasized that science and technology are the primary productive force, talents are the primary resource, and innovation is the primary driving force. The strategy of rejuvenating the country through science and education, the strategy of strengthening the country with the talents, and the strategy of innovation-driven development will be deeply implemented. Innovation needs innovative talents. As the backbone of science and technology innovation, the cultivation of college students' innovation ability has been incorporated into the national innovation development strategy^[1,2]. As far as the teaching level is concerned, it has become the key of teaching reform in colleges and universities that how to cultivate students' innovation and entrepreneurial ability^[3].

The State Council has successively issued documents such as the "Implementation Opinions of the General Office of the State Council on Deepening the Reform of Innovation and Entrepreneurship Education in Higher Education Institutions" and the "Opinions of the State Council on Promoting the High Quality Development of Innovation and Entrepreneurship and Creating an Upgraded Version of Double Innovation and Entrepreneurship". In these documents, the directions and requirements for innovation and entrepreneurship education in universities are clearly provided. In 2019, the notice of

“on the construction of demonstration universities for deepening innovation and entrepreneurship education reform in 2019” is issued by the Ministry of Education. The notice requires the exploration and enrichment of innovation and entrepreneurship education resources for various professional courses, and the organic integration of professional knowledge teaching and innovation and entrepreneurship ability training. In the comprehensive promotion of the construction of the innovation and entrepreneurship curriculum system with the core concept of cultivating innovative talents, it is necessary to integrate, promote, and coordinate with the traditional professional education system of universities^[4,5]. Being the public basic course for science and engineering majors, College physics plays a unique role in cultivating students' innovative literacy that cannot be replaced by other courses^[6].

2. Feasibility of Innovation and Entrepreneurship Ability Training in College Physics Teaching

First of all, college physics course starts early, which is usually offered in the second semester of the first year of university. And as a public basic course, college physics is aimed at students majoring in science and engineering throughout the university, with a natural and wide audience. It can be helpful to establish students' sense of innovation by introducing the innovation and entrepreneurship ability training in the teaching of the course. And the sense of innovation can not only play an important role in strengthening, but also effectively improve the learning efficiency in the subsequent learning.

Secondly, the subject characteristics of college physics determine that it is possible to develop the cultivation of creative thinking and abilities in the learning of college physics. As a fundamental natural science, Physics has distinct methodological and logical characteristics. Physics is the primarily methodology, containing a wealth of thinking methods such as symmetry and conservation, concrete and abstract, generality and individuality, induction and deduction, etc. Many laws in physics come from observing, analyzing, and summarizing natural phenomena. And then become standard laws or theorems by using rigorous logical deduction^[7]. For example, the isotropy of co-motion and separate motion in kinematics, the derivation of Newton's first law in classical mechanics, the establishment of the concept of "field" in electromagnetics, and the discussion and contemplation of the nature of light in optics. It can not only help with the study of physics but also benefit the learning of other knowledge to understand and master the scientific thinking and analysis methods involved in these sciences.

Thirdly, as a fundamental course, physics encompasses topics such as force, heat, electromagnetism, optics, relativity, and modern physics, covering various aspects of engineering applications. College physics can not only be combined with traditional disciplines such as materials science and mechanics, but also with emerging interdisciplinary fields such as cloud computing, big data, artificial intelligence, and "Internet +"^[8].

For the reasons mentioned above, recently the research and practice on physics learning and innovative quality cultivation in China universities have received increasing attention. Provinces and cities such as Zhejiang, Shandong, Hubei, and Chongqing have successively launched college physics innovation competitions to encourage the combination of course learning and innovative quality cultivation^[9]. At the university level, Huazhong University of Science and Technology has explored and practiced the mode of combining college physics and innovative quality cultivation by establishing a computer software platform as an innovative education platform and opening the College physics CCBP course group. Table 1 shows the query results for national undergraduate innovation training projects from 2020 to 2022, with the keywords "mechanics," "thermodynamics," "optics," and "electromagnetism". The results of the project approval show that the number of projects related to physics has remained stable in recent years. Among the approved innovative projects, there

are topics that combine physics with chemistry, materials, biology, and other fields, which also fully demonstrate the possibility of carrying out innovative and entrepreneurial education for different majors.

Table 1: The query results of the national college students' innovation training project approval

Keyword/number	mechanics	thermodynamics	optics	electromagnetics	subject code(0702)
Projects of 2022	299	10	74	102	628
Projects of 2021	228	11	72	120	554
Projects of 2020	262	14	74	85	562

3. Difficulties Faced by Cultivating the Innovation and Entrepreneurship Ability in College Physics Teaching

Although the college physics course have advantages in disciplines and audience in the cultivation of innovation and entrepreneurship ability, it also inevitably faces some difficulties.

Firstly, as a public basic course, college physics is generally faced with the dilemma of credit hour compression under the background of new engineering construction in recent years. On the one hand, the knowledge system of the course has rich content and strong theoretical foundation, and on the other hand, the course hours are continuously compressed. It is the important problem in current college physics teaching that how to provide innovation and entrepreneurship education to college students while completing the construction of knowledge system in the limited time.

Secondly, the characteristics of basic course determines its emphasis on the teaching and learning of theory, especially the principles and laws, while there are relatively few practical exercises for practical applications and specific cases. Practical operation ability, as well as scientific thinking methods and careful logical reasoning ability, are indispensable and important factors for the cultivation of innovative thinking and entrepreneurial ability. Therefore it is necessary to incorporate more practical content into college physics teaching.

Thirdly, as a public basic course, college physics faces the students from different majors and levels. They always exhibit diverse characteristics in their cognition and demands for college physics based on their own professional planning and development requirements. Especially there is a general lack of innovation motivation for the students with relatively weak foundations. To enhance the students' participation and enthusiasm, the learning process of innovation and entrepreneurship education should be targeted to their professional characteristics and individualized needs.

4. Practice of Cultivating Innovation and Entrepreneurship Ability Based on Blended Online and Offline Teaching

In recent years, with the popularity and development of online teaching technology, blended online and offline teaching based on online platforms has provided great convenience and possibilities for implementing innovation and entrepreneurship education in college physics. The combination of online and offline teaching is conducive to students making full use of fragmented time for learning, greatly expanding the time and space of teaching. The teaching mode of online and offline integration not only provides students with visual and auditory intuitive feelings but also reproduces some physical processes that are not easy to demonstrate directly through online platforms. Moreover, computer simulation experiments can achieve independent control over experimental conditions, processes, etc., which is conducive to learners experiencing experiential learning in simulated real-life practical scenarios. In addition, the data management system based on online platforms can enable teachers to achieve "one-to-many" process management, effectively improving the efficiency of innovation and entrepreneurship education.

4.1. Reconstruction of Key Concepts and Laws and Cultivation of Creative Thinking Skills

Innovation doesn't always have to be glamorous, but rather comes from inheriting and advancing existing knowledge. The course constructs a "concept-method-application-value" module to classify and integrate chapter contents. With a unified module design and teaching, the course effectively links knowledge from different chapters, promoting advancement step by step.

Using the concepts of velocity and acceleration in Chapter 1 of college physics as an example, the content was restructured based on knowledge and logical progression. Starting from the general definitions of velocity and acceleration given in Chapter 1, the topics were gradually expanded to include angular/linear quantities in circular motion, relative/absolute velocities, and vibrational and wave velocities and accelerations. Through analyzing the meanings of velocity and acceleration in different motion scenarios, students not only experience the logical connections between different concepts but also form good thinking habits through comparison and summarization processes.

In addition, with the help of online platforms, the course set up a student work section in the value shaping module, where excellent student works produced during the learning process were shared and exchanged to encourage experiential learning.

4.2. Project Based Task Design for Integrating Innovation and Entrepreneurship Ability Training

The project-based tasks are designed according to the needs of students from different majors and levels, including mind mapping, video learning, topic reports, professional development, and online testing. And the individual differences among students are also considered in the task-design. The students can participate in small groups or complete independently, while the teachers provide online and offline learning support during the project completion process. The support provided by teachers includes providing teaching resource packages around project tasks, teacher Q&A, online discussions, etc. Through the addition of online platforms, the promotion of project-based tasks is not limited to the school where students reside and their own majors. The enthusiasm of students has been greatly enhanced due to the opportunity to participate in communication and sharing on the platform. Next, the project-based task-design and resource package combining different majors are presented, taking Newton's laws of motion teaching as an example.

Project based task 1:

Oblique throwing motion under the action of constant resistance to variable resistance.

The equations of motion are more complicated when the resistance is taken into account. For computer science students, MATLAB programming is recommended to solve and simulate.

Resource package (partial):

Reference 1: Hao Chenghong. Projectile Range Considering Air Resistance [J].

Project based task 2: Dynamics Problems in Automotive Engine Vibration.

The vibration problem of automobile engine is presented to students majoring in machinery and electronics.

Resource package (partial):

Video: [https:// mbd.baidu.com/ma/s/fz6EF7Q9](https://mbd.baidu.com/ma/s/fz6EF7Q9);

Document: Graphical Analysis of Vibration in Automotive Engines.

In addition to project tasks combined with course content, project tasks designed based on teachers' own teaching and research practices are also an important source of project-based tasks. In recent years, many universities have established open teaching laboratories and innovation laboratories with the improvement of funding and educational conditions. These laboratories can also provide the possibility for teachers to design project teaching based on scientific research and teaching practice. Einstein once said, "Raising a problem is often more important than solving it". By encouraging the

students to design and operate independently, their thinking habits of discovering and solving problems can be cultivated. Moreover, it can also guide the students to develop a sense of collaboration, sharing, and innovative practical abilities in achieving tasks. In addition, it is possible to cultivate students' innovative thinking and abilities in practice by organizing them to participate in various innovative experimental competitions, and so on.

4.3. Innovation and Entrepreneurship Literacy Education Based on the History of Physics

Firstly, scientific thinking methods are the soul of innovative thinking and abilities. And the development process of physics has left us with a wealth of valuable experience in scientific research methods, such as ideal experiments, particle models, atomic models, and other physical or mathematical models. It can help students master the correct scientific research methods and become familiar with the process of scientific exploration by introducing this part appropriately^[10].

Secondly, there are also many figures and examples in the history of physics that have missed significant discoveries due to a lack of innovation and adherence to tradition. For example, the Jolios missed the discovery of neutrons, even though they were so close to the discovery of neutrons. And Lorentz and Poincare proposed the Lorentz transformation but failed to further propose the principle of relativity^[11]. It can effectively guide students to actively think and help them establish an innovative awareness of actively discovering problems by studying these historical facts.

Thirdly, the forefront of contemporary physical technology development should be actively introduced. The emerging disciplines are all based on physics such as quantum information, biophysics, optoelectronics, astrophysics and so on. A large number of new physical technologies are widely used and affect our lives. Nanotechnology, communication technology and space exploration are all closely related to physics. The students' learning interest can be stimulated by introducing the cutting-edge development of contemporary physics technology. And then the innovation ability can be cultivated when the students begin to think and practice actively.

The physics history education is usually difficult to carry out because of the limited class hours in traditional offline classroom. In a hybrid online and offline classroom, teachers use online platforms to publish relevant teaching resources. And the students learn independently based on their own interests and needs. Then the teachers can provide feedback and adjustments based on learning data such as viewing time and frequency of resources. This has a good effect on cracking the difficulties of class hours and conducting physics history education.

5. Conclusion

At present, China's economy has entered a stage of development driven by traditional production factors to innovative factors. Building an innovative country is a major strategy for China's economic development and technological innovation at this stage. Building an innovative country requires innovative talents. The multidisciplinary and multi-level innovation quality training system should be established in higher education to shoulder the responsibility of cultivating outstanding talents with innovative awareness and abilities. In the context of the construction of the new engineering discipline, the teaching of college physics should be combined with its characteristics and guided by the needs of students from different majors and levels as a public basic course in universities. And the course can also make its contributions to the cultivation of competitive innovative talents by actively exploring the cultivation mode of students' innovative thinking and practical ability.

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