

# Exploration on the Development and Practice of Senior High School Physics Curriculum Resources from the Perspective of Core Literacy

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## Abstract

Against the backdrop of the continuous advancement of the new college entrance examination reform and educational informatization, the development and utilization of curriculum resources have become a key link in deepening the reform of physics teaching. Guided by constructivist theory and based on the framework of core literacy cultivation, this paper systematically analyzes the connotation and development value of senior high school physics curriculum resources, and deeply explores the diversified practical paths for the development and utilization of physics curriculum resources. Through the above research, it aims to provide an operable practical paradigm for the innovation of senior high school physics teaching, thereby contributing to the effective cultivation of students' physics core literacy.

## Keywords

Core literacy; Senior high school physics; Curriculum resources; Development; Practice.

## 1. Introduction

As China's new curriculum reform advances in depth, the importance of curriculum resources has become increasingly prominent. Under the new college entrance examination model, the requirements for assessing students' core literacy are constantly rising, which necessitates the support of rich and diverse curriculum resources. Without the guarantee of good curriculum resources, even the most advanced educational reform concepts will struggle to achieve the expected results. Research on the development and utilization of curriculum resources is not only a new topic that conforms to the trend of educational development, but also a key practical issue that needs to be solved urgently in the process of the new curriculum reform. This paper focuses on senior high school physics curriculum resources, deeply analyzes the connotation, value and practical application paths of their development and utilization from the perspective of subject literacy, aiming to provide references for physics teachers and physics curriculum researchers, helping them better develop and utilize physics curriculum resources and explore innovative ideas for physics teaching.

## 2. The Connotation of Physics Curriculum Resources

### 2.1. Conceptual Reconstruction

According to The Curriculum Standards for Physics in General Senior High Schools (2017 Edition, Revised in 2020), physics curriculum resources refer to "the sum of all factors that are conducive to achieving curriculum goals", which include three major categories: material resources (laboratories, digital equipment, etc.), human resources (teachers, students, experts, etc.), and information resources (teaching materials, online databases, etc.) <sup>[1]</sup>. Their extension

has shown a significant expansion in the information age, as new-type resources such as VR virtual experiment systems and AI adaptive learning platforms have become important components.

## 2.2. Theoretical support

Constructivism emphasizes the initiative and situational nature of learning, providing methodological guidance for the development of curriculum resources. Piaget's cognitive development theory points out that students realize the reconstruction of cognitive schemas through interaction with the environment (resources), which requires that resource design should include cognitive triggers of "assimilation – accommodation" [2].

The core literacy framework (physical concepts, scientific thinking, scientific inquiry, scientific attitude and responsibility) provides a value coordinate for resource development. Studies have shown that targeted resource design can increase the passing rate of students' scientific inquiry literacy by 27.3% (monitoring data from the Ministry of Education in 2023) [3].

## 3. The Value of Physics Curriculum Resource Development

### 3.1. Promote students' cognitive development

The development of curriculum resources systematically influences all aspects of students' cognitive development through the path of "material activation - process support - conflict guidance - monitoring reinforcement - transfer and expansion". It not only consolidates the foundation of knowledge but also improves the quality of thinking, ultimately achieving the sustainable development of cognitive ability. This also deeply aligns with the cultivation requirements of such dimensions as "scientific thinking" and "scientific inquiry" in core literacy. For example, a controlled experiment in our school shows that the experimental group, which adopted multiple resource packages (including virtual experiments, the National Smart Education Network for Primary and Middle Schools, and the Yuejiao Xiangyun Digital Platform) for teaching, scored 9.5 points higher on average in the "celestial motion" unit test than the traditional teaching group. Moreover, 80% of the students in the experimental group could independently design verification experiments (compared with 56% in the control group). This confirms the role of resource development in promoting students' knowledge transfer ability, among which digital resources have particularly prominent advantages. Through the analysis of a large number of teaching samples, it is found that in classes using the DIS experimental system, the passing rate of students' data processing ability reaches 82.3%, significantly higher than 56% in traditional experimental teaching. In terms of visualizing abstract concepts through virtual experiment platforms, for instance, the simulation resources of electric field lines can improve students' understanding efficiency by more than 40% [4].

### 3.2. Transform the way of physics learning

The concept of the new physics curriculum strengthens the awareness of scientific inquiry and advocates diversified learning methods, which has effectively promoted the transformation of students' learning styles. This means that the focus of teaching has shifted from simply emphasizing the inheritance and accumulation of knowledge in the past to focusing on the inquiry process of knowledge. For example, in the case of project-based learning under the background of the new college entrance examination, students take "exploring the physical principles of sensors" as the research topic. The resource package (including industry reports and sensor experiment kits) developed around the theme of "physical principles of sensors" has increased students' classroom participation from 58% to 91%, and 6 original inquiry schemes have emerged in the project results. This transformation confirms the practical effect of Dewey's "learning by doing" theory with the support of resources, fully embodies the educational idea of "student-centered development", and students have transformed from

passive knowledge receivers to co-constructors of knowledge, with their learning enthusiasm and initiative fully stimulated.

Surveys show that among teachers who can skillfully develop and integrate resources, 86% adopt inquiry-based teaching, which is 46 percentage points higher than the group of traditional teachers.

### **3.3. Cultivate innovative ability and scientific attitude**

In traditional physics experiment teaching, limited by conventional experimental conditions—such as having multiple students share a single experimental setup—some students have fewer opportunities to operate experiments with their own hands. Moreover, the experimental process often follows a “cookbook” approach, where students lack in-depth thinking and remain in a passive position. However, introducing online virtual physics experiments into teaching can create a broad space for innovative design, modification, and combination of experimental methods. This has a significant effect on activating students’ thinking, stimulating their desire to create, and cultivating their innovative abilities. For example, students can try out different experimental schemes in a virtual experimental environment, break free from the constraints of real-world experimental conditions, and explore new physical phenomena and laws.

Meanwhile, the development of physics curriculum resources focuses on carefully selecting the basic knowledge and skills necessary for students’ lifelong learning, strengthening connections with students’ lives, modern society, and the development of science and technology, reflecting important achievements and new scientific ideas in the development of contemporary science and technology, paying attention to social issues caused by the application of physics and technology, and cultivating students’ sense of social participation and scientific attitude of being responsible for society. For example, when learning the knowledge of “electromagnetic induction”, students are guided to pay attention to the application of electromagnetic induction in new energy power generation, as well as social issues such as energy structure transformation and environmental protection brought about by it<sup>[5]</sup>.

## **4. Paths for the Development and Utilization of Physics Curriculum Resources**

### **4.1. Strive to develop human resources in physics courses**

Human resources are the most dynamic and variable component of curriculum resources, and often play a leading or even dominant role in the development of physics curriculum resources. The development and utilization of human resources in physics courses mainly consider three aspects: students, teachers, and teacher-student interaction:

#### **4.1.1. Develop curriculum resources among teachers**

Against the backdrop of the new college entrance examination and educational informatization, teachers are not only organizers and facilitators of the implementation of the new curriculum, but also developers and researchers of the curriculum. The quality of teachers determines the scope of identification, the degree of development and utilization, and the level of benefit exertion of curriculum resources. In the construction of curriculum resources, efforts should be made to enhance teachers’ awareness of curriculum resources and their ability to develop and apply them, especially their ability to identify, capture, accumulate, utilize, and develop dynamically generated curriculum resources in classroom teaching. Through the breakthrough of teachers as a key curriculum resource, the optimized development of other curriculum resources can be driven<sup>[6]</sup>.

Teachers’ own qualities, personal charm, life experience, and wisdom are precious assets to students and have a profound impact. From knowledge to ability, from emotions to attitudes

and values, teachers' influence runs through all aspects of education, such as learning wit, life strategies, life attitudes, the wisdom of cooperation, respect for nature, exploration of science, and perception of true feelings. The improvement of teachers' abilities, the enhancement of their qualities, and the demonstration of their potential have a strong attraction and educational effect on students. For example, when teachers share their experiences of participating in scientific research projects in class, it can stimulate students' interest in and yearning for scientific research. Therefore, teachers should attach importance to the development and utilization of their own resources.

#### **4.1.2. Develop curriculum resources among students**

As both educational objects and learning subjects, students' knowledge, experience, interests, emotions, individual differences, and even mistakes are all important curriculum resources. Regarding students' personal knowledge, direct experience, and life world as important curriculum resources is not only a key viewpoint of constructivism but also one of the core concepts of the new curriculum reform [7].

Students' experiences, emotions, and attitudes are intangible curriculum resources. Students' existing knowledge level, cognitive structure, and social experience serve as the starting point of teaching. Starting from students' existing knowledge and experience can help them better understand physics knowledge. For example, when learning about "electric field", we can start from electrostatic phenomena familiar to students, such as the electrostatic sparks when taking off sweaters in winter, to guide students to gradually deepen their understanding of the concept of electric field. Students' interests are also important resources. Interest is the driving force of learning, and combining teaching activities with students' interests can achieve twice the result with half the effort. Piaget once pointed out that all effective work takes interest as a prerequisite, and teachers should focus on cultivating students' interests in teaching [8].

There are individual differences among students, and such differences are also teaching resources. Differences lead to conflicts and sharing. By making use of differences, students can be exposed to different viewpoints, strengthen cooperative learning, improve their understanding of things, and enrich and expand their own cognition. For example, in group cooperative learning, different students' different understandings and solutions to physical problems can inspire each other and promote common progress. From an educational perspective, the problems and mistakes made by students are opportunities for them to improve themselves. Teachers should focus on students' development and progress and give full play to the value of this "resource" [9].

#### **4.1.3. Generating physics curriculum resources in "teacher-student interaction"**

Under the autonomous, cooperative, and inquiry-based learning model advocated by the new college entrance examination, a large number of physics curriculum resources continue to emerge and be generated in "interactive teaching" and "dialogical teaching". Such curriculum resources are characterized by instantaneity, unpredictability, and irrepeatability. A meaningful teaching process is not only a process where students learn objective knowledge, but also a life process in which teachers and students jointly construct knowledge and life using curriculum resources. When teachers' and students' life experiences, wisdom, understandings, questions, confusions, emotions, attitudes, values, and other material curriculum resources are integrated into the curriculum, creating a harmonious and pleasant teaching atmosphere, both teachers and students can truly feel that the teaching process is part of their lives, and teaching can really promote students' healthy growth and all-round development. For example, in classroom discussions, the novel viewpoints and questions put forward by students may trigger in-depth discussions between teachers and students, thereby generating new curriculum resources.

## 4.2. Dig deep into the curriculum resources of physics textbooks

Textbooks are the most important resource available to schools and teachers in their educational work. As a crucial carrier of teaching content, textbooks are not only a source from which students acquire various physical knowledge and information, but also a basis for students to develop various abilities, and a tool to inspire students' thinking and develop their wisdom. With the deepening of curriculum reform, high-quality and diversified textbooks have become an inevitable trend. Every new textbook approved by the state embodies the efforts and wisdom of experts, scholars, and a large number of teachers. These new textbooks are undoubtedly extremely valuable curriculum resources, worthy of careful study and reference by every teacher and teaching researcher. Schools and teachers should make full use of favorable conditions and select textbooks suitable for the characteristics of their own schools and the needs of students according to their actual situations.

At the same time, we should not regard it as the only physics curriculum resource; instead, we should actively and in-depth explore new textbooks. The new physics textbooks have added a large amount of content related to daily life, society, and science and technology, presented in a way that combines pictures and texts, which enhances the interest and vividness of the textbooks. Among them, many relevant reading materials, family experiments, and optional learning contents are things that students are very interested in. If teachers can actively make use of them, it will surely promote teaching and improve teaching quality. Meanwhile, we should not be limited to learning from textbooks. Instead, in accordance with the requirements of the physics curriculum standards, we should absorb and utilize various curriculum resources that are beneficial to students' development to enrich the content of physics courses.

### 4.2.1. Conduct an in-depth comparative analysis of old and new textbooks

Study the differences between the two in terms of educational concepts, content, organization and presentation methods, and strive to explore new ideas. Here, the concept of "secondary development" should be established: the compilation of textbooks by textbook compilers is the first development, and the study of textbooks by teachers and their mastery together with students is the second development. The content system, presentation methods and the implied educational concepts of the new textbooks are all worthy of in-depth study by teachers.

### 4.2.2. Attach importance to the application of extended knowledge in textbooks

In addition to the compulsory content, the new textbooks also include optional content, and set up columns such as "Materials", "Reading", "Discussion", "Family Experiments", and "Research Topics", which reflect the S-T-S (Science-Technology-Society) value orientation of physics courses. Teachers should make full use of these contents to achieve the teaching goals of the new curriculum, rather than abandoning them for fear of tight class hours. For example, carrying out classroom research-based learning on "Electromagnetic Pollution in Life" and organizing students to conduct relevant surveys and experiments can not only broaden students' horizons but also effectively cultivate their scientific inquiry ability.

### 4.2.3. Integrate textbooks across versions

A comparative study of textbooks published by People's Education Press, Shandong Science and Technology Press, Shanghai Science and Technology Press, and Guangdong Education Press shows that these textbooks each have their own characteristics and are highly innovative, worthy of reference and utilization. The thematic resource packages developed through integration have significantly improved the structuring of students' knowledge [10].

## 4.3. Actively develop and effectively utilize the curriculum resources of the laboratory

Experiments are an important part of physics curriculum reform and a crucial way to achieve physics curriculum goals and comprehensively improve students' scientific literacy. Many

teaching contents in the curriculum standards require learning through scientific inquiry activities, and the implementation of scientific inquiry activities is inseparable from necessary scientific instruments. Therefore, laboratory resources are the most important resources in physics courses.

#### **4.3.1. Maximize the role of existing equipment in the laboratory**

Schools and teachers should make great efforts to strengthen demonstration experiments and student experiments. They should arrange a sufficient number of student experiments and demonstration experiments in accordance with the requirements of the curriculum standards, maximize the use of existing equipment in the laboratory, fully explore their experimental functions, and achieve the goal of “one object with multiple uses”. Secondly, they need to use their brains and find ways to make full use of equipment that has been idle for many years to develop new experiments, so as to realize the reuse of waste materials. Furthermore, they can reform existing instruments and experiments as well as outdated ones, optimize their combination, and design new experiments.

#### **4.3.2. Establish an open laboratory**

In some schools, it seems that instruments can only be used by students in physics classes, and most of the time they are kept locked in the instrument room. This practice is a great waste of resources. To fully develop and utilize the rich curriculum resources of laboratories, it is necessary to change the closed management mode of laboratories. Laboratories should be open to students. By establishing open laboratories or setting up experimental corridors and other forms, students are encouraged to take the initiative to do extracurricular experiments and carry out various inquiry activities with experimental instruments. Laboratories should continuously add and update instruments and equipment to create reliable material conditions for students' scientific inquiry activities. Data from our school's open laboratory shows that the number of student-designed experiments increases by 37% annually on average, among which 3 achievements have won awards in youth science and technology innovation competitions.

#### **4.3.3. Systematic Construction of Digital Resources**

The in-depth integration of information technology with physics experiments is an important symbol of the modernization of physics experiments and also the development direction of physics experiments today. Efforts should be made to accelerate the development and application of middle school physics experiment software, and use devices such as sensors and data collectors to realize the automatic collection and analysis of experimental data. For example, the DIS experimental system can be used to accurately measure physical quantities such as the velocity and acceleration of object movement, making the experimental results more accurate and intuitive [11].

#### **4.4. Informatization of Physics Curriculum Resources**

The informatization of curriculum resources is a new concept of curriculum resources. It refers to teaching resources with curriculum value that have been digitized and can run on multimedia computers or network environments. The new curriculum requires us to realize the informatization of curriculum resources, develop and utilize network resources, and complete the transformation of curriculum resources from single printed materials to network resources.

### **5. Conclusion**

In short, for the development and utilization of physics curriculum resources, it is necessary to properly coordinate the relationships between “collaboration and autonomy” and “navigation and openness”. By selecting, adding, deleting, and integrating teaching materials, experimental instruments, network resources, etc., we can construct a “open” physics classroom with a clear orientation. At the same time, we should combine human resources with material resources to

create a harmonious and pleasant physics learning atmosphere that is based on collaboration and advocates autonomy, laying a solid foundation for the implementation of the new physics curriculum.

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