Journal of Education and Educational Research
ISSN: 2957-9465 | Vol. 17, No. 1, 2026

Interdisciplinary Physics Teaching in High School

Cang Wu

Shandong Experimental High School, Jinan Shandong, 250109, China

Abstract: The Ministry of Education proposed the concept of "interdisciplinarity" in the "*National Medium and Long-Term Education Reform and Development Plan Outline,*" which emphasizes the need for "integrated" student cultivation to improve their ability to comprehensively analyze practical problems. The interdisciplinary concept injects new momentum into high school physics teaching. It not only helps students analyze complex natural phenomena from a holistic perspective but also cultivates their ability to use cross-disciplinary knowledge to solve real-world physics problems, laying the foundation for cultivating interdisciplinary talent. This paper elaborates on how to reasonably carry out interdisciplinary physics teaching,and illustrate with practical examples.

Keywords: Physics; Interdisciplinarity; High School.

1. Introduction

The "*High School Physics Curriculum Standards*" explicitly state that high school physics curriculum content should enhance connections with modern social, technological, and production life, showcase important scientific and technological achievements in the world today, pay attention to social issues arising from technological applications, and focus on cultivating students' correct scientific attitudes and social responsibility. Physics classroom teaching should create scenarios conducive to student thinking and inquiry; physics teaching designs should stimulate student interest in learning and foster their capacity for self-directed learning. Traditional teaching methods are singular, lack real-world context, and often lead students to memorize principles mechanically, neglecting the importance of the scientific inquiry process. This makes it difficult for students to establish a connection between theory and the real world. [1-2]

The interdisciplinary approach to high school physics teaching can break down traditional disciplinary barriers, help students integrate theory with practical life, and cultivate their ability to analyze complex natural phenomena holistically and solve real-world physics problems. This paper will explain the concept of interdisciplinary teaching, explore pathways for its implementation in high school physics, aiming to enhance its effectiveness and improve students' core competencies in physics.

2. Interdisciplinary-Based Physics Teaching

Table 1. Comparison of Traditional Physics Teaching and Interdisciplinary Physics Teaching

Comparison Dimension	Traditional Physics Education	Interdisciplinary Physics Education
Goal	Master physics knowledge and skills, improve problem-solving ability.	Cultivate interdisciplinary thinking, physics model construction ability, comprehensive literacy, and practical problem-solving skills.
Method	Lecture-based, extensive problem drills, focus on formula memorization and problem classification.	Interdisciplinary scenario creation, task-driven learning, integration of multi-disciplinary knowledge, project-based learning, experimental inquiry, and collaborative learning.
Student Role	Teacher-led, students passively receive.	Teacher-guided and coordinated, students actively construct, explore, and express.
Evaluation	Primarily exam scores, emphasis on summative assessment.	Emphasis on process evaluation, multi-subject participation (self-assessment, peer assessment, teacher assessment).
Effect	Improves test-taking ability, but weakens model construction and transfer skills.	Enhances learning interest, model construction ability, innovative thinking, and interdisciplinary comprehensive application ability.

Interdisciplinary teaching breaks through traditional subject boundaries, organically integrating two or more disciplinary fields or combining them with life, engineering, and society. It encourages students to transcend disciplinary borders for comprehensive thinking and solving complex real-world problems. Its essence is project-driven learning based on authentic contexts, guiding students to analyze, synthesize, and innovate from multiple disciplinary perspectives.

Interdisciplinary-based physics teaching is a diversified approach grounded in physics knowledge, guided by solving practical problems in daily life and engineering, and assisted by knowledge from mathematics, chemistry, geography, and other disciplines. Through this "project +diversified" teaching practice, students can not only solidly master physics knowledge but also form a profound understanding of the integrity and diversity of the natural world, thus achieving a shift from learning disciplinary knowledge to scientific practice application. Table 1 compares traditional physics teaching with interdisciplinary physics teaching. [3]

3. Pathways for Implementing Interdisciplinary Teaching in High School Physics

Implementing interdisciplinary teaching in high school physics requires teachers not only to analyze student situations but, more importantly, to analyze the teaching

content, establish models based on this, and simulate real-world scenarios. Interdisciplinary teaching places high demands on teachers. During the preliminary course preparation, teachers need to conduct in-depth analysis of the teaching content, comprehensively analyze the corresponding knowledge points of physics theory, and attempt to connect physics knowledge with other disciplines or with life, society, and engineering, then organize and summarize these connections. Therefore, this is the most crucial step in interdisciplinary teaching. The specific implementation is as follows:

3.1. Organizing Life and Engineering Contexts Related to Course Content

Effective teaching requires the deep integration of technology, pedagogy, and content knowledge (TPACK), and contextualization is the key path to achieving this integration. The curriculum standards clearly state that physics teaching should focus on "from life to physics, from physics back to life." Many physics concepts and models originate from the refinement of practical life problems, and products based on physical principles are widely used in daily life. Specific examples can be found in Table 2.

Table 2. Examples of Life, Engineering, and Physics Contexts

Physics Theory Knowledge	Specific Application Area	Manifestation and Description
Newton's Laws of Motion, Energy Conservation	Daily Life: Automotive Braking System	Manifestation: The car braking process. Description: When the driver presses the brake pedal, the hydraulic system (Pascal's principle) transmits force to the brake caliper, creating significant friction between the brake pads and disc (Newton's third law). This friction does negative work, converting the car's kinetic energy into internal energy (heat), slowing the car until it stops based on the work-energy theorem and energy conservation law. The braking distance is proportional to the square of the initial speed, directly reflecting kinematic principles.
Electromagnetic Induction (Faraday's Law)	Major Engineering: Hydroelectric, Wind Power Generation	Manifestation: Power plant generators. Description: The gravitational potential energy of water in a dam or the kinetic energy of wind drives a turbine (rotor). The turbine rotates large magnets inside a set of coils, cutting magnetic field lines, thereby generating an electromotive force and induced current in the coils, converting mechanical energy into electrical energy. This is the most grand and direct application of Faraday's Law of Electromagnetic Induction, the cornerstone of the modern electrical industry.
Laws of Thermodynamics (Especially Second Law)	Household Appliances: Refrigerators, Air Conditioners	Manifestation: Refrigeration cycle. Description: Refrigerators and air conditioners do not "create cold"; rather, they use a compressor to do work on a refrigerant, forcibly moving heat from the cooler interior space (inside the fridge or room) to the warmer exterior environment. This process counteracts the spontaneous direction of heat transfer (from hot to cold) and must consume electrical energy (work), perfectly illustrating the Second Law of Thermodynamics.
Fluid Mechanics (Bernoulli's Principle)	Transportation: Aircraft Wings	Manifestation: Aircraft lift. Description: An aircraft wing is designed with a streamlined, more curved upper surface and a relatively flat lower surface. When the aircraft taxis, air flows over the wing. The airflow speed is faster over the upper surface, resulting in lower pressure, while the speed is slower under the lower surface, resulting in higher pressure. This pressure difference, created by Bernoulli's Principle, generates an upward net force, i.e., lift. When lift exceeds the aircraft's weight, the aircraft takes off.
Optics (Refraction and Reflection of Light)	Information Technology: Fiber Optic Communication	Manifestation: Internet data transmission. Description: Optical fibers consist of a core with a high refractive index and a cladding with a lower refractive index. When a laser signal enters the core at a specific angle, total internal reflection occurs, confining the light within the core. It propagates forward through numerous reflections, like in a pipeline, transmitting information (data) at the speed of light over long distances. This utilizes the principle of total internal reflection, enabling low-loss, high-capacity, high-fidelity modern communication.

3.2. Organizing Disciplinary Knowledge Related to Course Content

Teachers' knowledge base directly impacts teaching implementation. Therefore, for interdisciplinary teaching, finding an entry point is very important and necessary. After identifying interdisciplinary knowledge points, teachers need to organize and analyze them to achieve integration between physics knowledge and other disciplines.

Table 3. Examples of Interdisciplinarity between Humanities Knowledge and Physics

Physics Knowledge	Humanities Integration Point	Description
Inertia	Novel plot (e.g., cavalry charge in Romance of the Three Kingdoms)	In the novel, when a cavalryman charges and the horse suddenly stops, the person continues moving forward due to inertia. This vividly demonstrates the principle that an object remains in its state of motion unless acted upon by an external force.
Reflection of Light	Poetry (e.g., Li Bai's "I watch the bright moon, And, bowing, think of my old home.")	The poetry describes moonlight illuminating the earth. Moonlight is essentially sunlight reflected from the moon to the Earth. This can introduce the principle of light reflection, helping students understand the path of light rays.
Buoyancy	Historical story (e.g., Archimedes and the Golden Crown)	Archimedes discovered the principle of buoyancy in his bath. This story can vividly explain the relationship between the buoyant force on an object in a fluid and the volume of fluid displaced.
Heat Conduction	Novel plot (e.g., scenes with warming stoves in Dream of the Red Chamber)	The novel describes characters using warming stoves, which involves the transfer of thermal energy from a higher temperature object to a lower temperature object. This can introduce the concept of heat conduction, helping students understand energy transfer.

The integration of physics with humanities knowledge is generally reflected in the introduction phase of a lesson. When introducing physics concepts, teachers can use poetry, novel plots, etc., to help students better understand abstract physics knowledge. For example, the line "The empty hills show no man, yet voices of men are heard." vividly depicts

the propagation of sound through air. In the empty valley, although people cannot be seen, human voices can be clearly heard, which is the result of sound traveling through the medium of air. More examples can be found in Table 3.

The integration of physics with science disciplines is generally reflected in the lecture phase of a lesson. Mathematics often appears as a tool in the natural sciences, such as using calculus to explain acceleration; chemical phenomena often coexist with physical phenomena, especially in areas like heat, light, crystals, energy, and atomic transitions; biology and physics share many interconnected concepts and principles, such as systems and feedback, matter and energy, space and time, structure and function, dynamics and equilibrium. More examples can be found in Table 4.

Table 4. Examples of Interdisciplinarity between Natural Science Knowledge and Physics

Physics Knowledge Area	Integrated Natural Science	Specific Integration Point and Description
Kinematics and Dynamics	Mathematics (Calculus)	Integration Point: Using derivatives to describe instantaneous velocity and acceleration, using integrals to calculate work done by variable forces or displacement from velocity. Description: Mathematics provides precise quantitative descriptive tools for physics. For example, acceleration is the derivative of velocity with respect to time, and integrating the acceleration function over time yields the change in velocity. This reflects the role of mathematics as the language of physics.
Thermodynamics	Chemistry (Thermochemistry)	Integration Point: Application of the law of energy conservation and transformation (First Law of Thermodynamics) in chemical reactions. Description: Endothermic and exothermic phenomena in chemical reactions essentially involve the conversion between chemical energy and thermal energy. The laws of thermodynamics provide the core theoretical framework for calculating reaction heats (e.g., enthalpy change) and judging reaction direction. Both disciplines jointly study the forms and transformation laws of energy.
Optics and Atomic Physics	Chemistry (Spectral Analysis)	Integration Point: Energy level structure of atoms and molecules and characteristic spectra. Description: Physics reveals that when electrons in atoms transition between different energy levels, they absorb or emit photons of specific frequencies. This principle is the basis of spectral analysis in chemistry. Analyzing the characteristic spectra emitted by substances can determine their chemical elements and even molecular structure, achieving a leap from physical mechanism to chemical analysis.
Mechanics and Materials Science	Biology (Biomechanics)	Integration Point: The relationship between structure and function. Description: Mechanical principles in physics (e.g., Hooke's Law, lever principle) can explain the structural adaptations of organisms. For example, the hollow structure of bones ensures strength while achieving lightweight; tree trunks are cylindrical to withstand forces from all directions maximally. This embodies the core principle of "structure determines function," which is common to both physics and biology.
Electricity and Energy	Biology (Neurobiology)	Integration Point: Generation and conduction of electrical signals. Description: The action potential generated by neurons in organisms is an electrochemical signal. Its generation stems from the membrane potential (physical electric potential) caused by the difference in ion concentrations inside and outside the cell membrane (chemical potential energy). Its conduction conforms to the basic principles of electrical signal propagation along a cable (axon). This is one of the most direct manifestations of physics principles in life activities.

3.3. Steps for Classroom Teaching Implementation

Classroom teaching primarily revolves around three main phases: Introduction, Lecture, and Application. First, the Introduction: by organizing life and engineering contexts related to the course content (3.1), design the lesson's problem scenario to visualize theoretical knowledge. Second, the Lecture: by organizing disciplinary knowledge related to the course content (3.2), teachers should focus on exploring the intrinsic connections between physics and other disciplines, finding integration points at the levels of definition, principle, and method, and designing reasonable teaching content. Finally, Application: the lesson should follow the principle of "from whence it came, back there it returns." Interdisciplinary teaching should follow engineering practice principles. Practice serves as a bridge connecting theoretical knowledge with practical problems, enabling students to transfer theoretical knowledge to practical applications through real-world engineering contexts. Below, using the capacitor as an example, the flow of a lesson is briefly presented in Table 5. [4-5]

4. Conclusion

Interdisciplinary-based physics teaching differs from traditional physics teaching. It starts from practical application scenarios in life and uses knowledge from mathematics, chemistry, biology, and other disciplines to teach knowledge points. Interdisciplinary teaching is a complex and challenging task but holds significant practical importance for talent cultivation. Therefore, high school physics teachers should deeply understand the interdisciplinary concept, clarify the feasibility of constructing interdisciplinary physics classrooms, actively explore the connections between physics and mathematics, language, geography, and many other disciplines, find feasible paths for cross-border integration, and cultivate students' interdisciplinary awareness and perspective. The cultivation of interdisciplinary thinking and problem-solving helps develop students' comprehensive thinking and problem-solving abilities, helps shape well-rounded socialist successors, and helps develop students' future social adaptability.

Table 5. Capacitor Classroom Teaching

Teaching Phase	Specific Teaching Activities and Content	Design Intent and Explanation
Introduction (Creating Context, Visualizing Theory)	1) Context Presentation: Show a common USB-rechargeable LED emergency light or a small solar-powered lawn light. After turning off the power, it continues to glow for a period. 2) Posing Questions: "The battery stores the primary energy, but what continues to power the bulb the moment the power is switched off, causing it to fade out slowly instead of instantly turning off?" "In a camera flash, why is there a brief charging wait ('whirring' sound) between pressing the shutter and the flash?"	Creates a real problem scenario through everyday electronic devices students encounter. The questions directly target the core function of capacitors – "temporary energy transfer stations." The combination of physical objects and circuit diagrams makes the abstract concept of charge storage intuitive and perceptible, creating strong cognitive demand for new knowledge.
Lecture (Interdisciplinary Integration, Exploring Principles)	1) Establishing Physics Concepts (Integrating Mathematics): Mathematical Graphical Depiction: Use a demonstration experiment or simulation software to plot the curve of voltage across the capacitor during charging versus time *t*. Guide students to observe and summarize: this is an exponential growth curve, whose rate of change is determined by the time constant τ=RC. Similarly, the discharge process is an exponential decay curve. This reflects the profound connection between physical processes and mathematical function models. 2) Deepening Understanding (Integrating Chemistry): Microscopic Essence: Using an electrolytic capacitor as an example, explain that its interior contains an electrolyte, and the charging/discharging process involves complex electrochemical redox reactions. Positive and negative charges are essentially "bound" on either side of the dielectric, not flowing directly through. Energy Form Conversion: Ask: "When charging, what form of energy is the electrical energy from the source converted into and stored in the capacitor?" (Electric field energy). Further contrast with chemical batteries: Batteries convert chemical energy into electrical energy through chemical reactions, have high energy density, and release energy slowly; whereas capacitors store charge directly, establishing an electric field, allowing for fast charge/discharge speeds but lower energy density. This distinguishes physical devices from chemical devices based on the nature of energy storage.	The introduction of Mathematics elevates the understanding of the charging/discharging process from qualitative to quantitative and model-based. The exponential function graph gives students a clear understanding of the "non-linear" nature of the process. The integration of Chemistry reveals the microscopic mechanisms of different energy storage components, helping students understand the diverse forms of "energy storage" at the atomic and molecular levels, breaking students' singular understanding of "storing electricity" and establishing a more comprehensive view of matter and energy.
Application (Engineering Practice, Problem Solving)	1) Project Task Release: Task: Each group uses provided components (battery, resistor, large capacitor, switch, LED, transistor or 555 timer IC (optional, to enhance feasibility)) to design and build a delayed turn-off light circuit. Requirement: After closing the switch, the LED lights up immediately; after opening the switch, the LED should continue to light for 3-5 seconds before turning off. 2) Practice and Verification: Principle Analysis: Guide students to analyze: After the switch is opened, where does the energy sustaining the LED come from? (The electric field energy previously stored in the capacitor). The capacitor discharges through the LED and resistor. The discharge rate (delay length) is determined by what? (The time constant τ = R_discharge C). Design Calculation: Given the capacitance value C, require students to estimate the approximate range of the discharge resistor R needed based on the target delay time (e.g., 3-5 times τ). Construction and Debugging: Groups build the circuit according to their calculations and design. By replacing resistors of different values or capacitors of different capacities, observe and measure the change in delay time, and optimize the circuit to meet the task requirements.	This segment designs an engineering application related to but different from the introduction phase (energy buffer) – timing. This requires students to deeply understand the "time controllability" of the capacitor discharge process. Students need to act like electronics engineers, performing principle analysis, parameter calculation, hands-on soldering/breadboarding, and testing/debugging. This not only consolidates the core knowledge of capacitors but also cultivates students' circuit design thinking and ability to solve practical electronic technical problems, perfectly embodying the "from physics into life" concept.

References

[1] Ministry of Education of the People's Republic of China. National Medium- and Long-Term Educational Reform and Development Plan Outline [EB/OL]. 2010-07-29.

[2] Ministry of Education of the People's Republic of China. Physics Curriculum Standard for Ordinary High Schools[M]. Beijing: People's Education Press.

[3] Wang Yong. Research on the Instructional Design and Practice of Interdisciplinary Teaching in High School Physics Based on the TPACK Theory-Taking the Electromagnetism Section as an Example[D]. Guizhou Normal University.2025.

[4] Guan Quan. Research on Improving High School Students' Physical Model Construction Ability Based on the Interdisciplinary Teach[D].Inner Mongolia Normal University. 2025.

[5] Ma Yuanfang. Interdisciplinary Teaching Design for High School Physics within Everyday Contexts[J]. PHYSICSTEACHER, 2025,46(2),26-28.