**Journal of Innovation and Development**
ISSN: 2958-4752 | Vol. 7, No. 3, 2024

# The Cultivation of Critical Thinking Ability in Middle School Physics Teaching

**Yanxiang Gong *, Juan Guo, Xiangli Sun**

School of Physics and Electronic Engineering, Taishan University, Taian City, Shandong, 271000, China

*** Corresponding author:** Yanxiang Gong (Email: yxgong@sina.com)

**Abstract:** Critical thinking is the most fundamental way of thinking in evaluating, exploring, and developing activities, and is also a prerequisite for proposing and solving problems. How to cultivate students' critical thinking has become a crucial issue in middle school physics teaching. To implement the cultivation of critical thinking ability in physics teaching, it is necessary to cultivate the habit of scientific thinking among students in the process of questioning. Teachers should design teaching methods for cultivating critical thinking and continuously enhance students' critical thinking abilities in their scientific exploration activities. In the practical application of knowledge, their critical thinking skills are improved. Cultivating students' critical thinking is an important way to cultivate innovative talents.

**Keywords:** Middle School Physics; Critical Thinking; Physics Teaching; Teaching Reform.

## 1. Introduction

The new physics curriculum standards for compulsory education in China believe that "cultivating students' scientific inquiry ability is an important component of improving their scientific literacy.". Educator Barry K. Beyer pointed out in his article "What is Critical Thinking": "Critical thinking includes not only specific brain activities, but more importantly, a mode of thinking. The responsibility of teachers is to help students form this mode." So how can students achieve critical thinking as quickly as possible? Stephen P. Norris stated in his article "A Comprehensive Study of Critical Thinking" that "the primary goal is to encourage students to have a critical spirit." Students should be encouraged to dare to think, question authority, and act according to their own thinking. Bruce Joyce also said in his article "Teaching Thinking Models", "Teaching students to think independently gives them the ability to educate themselves and encourage them to express their opinions in the classroom. We cannot demand that students give up all active thinking and blindly believe in a certain conclusion. On the contrary, we should teach them to find the best conclusion through active thinking."

The 21st century is an era of information technology with a sharp increase in knowledge, which means that in such an era, everyone is faced with countless information options to choose from, and people must also make some choice in the complex information to adapt to their needs. If you do not have sufficient thinking ability, you will be lost in the vast ocean of knowledge. In China, the phenomenon of "exam oriented education" still exists to a certain extent, and even some teachers have behaviors that suppress students' questioning habits. But reality tells us that only by cultivating students' innovative abilities can we achieve the goal of revitalizing the country through science and education. As a high school physics teacher, we should provide correct guidance to students on their learning methods and train their scientific thinking, rather than using rote teaching. To prevent students from developing bad thinking habits of sticking to conventions and following the prescribed procedures. Critical thinking is the most important way of thinking in scientific thinking, which is crucial for cultivating students' innovative consciousness and creative spirit. This article first analyzes the advantages of cultivating students' critical thinking in middle school physics, and then discusses the specific methods of cultivating students' critical thinking.

## 2. Advantages of Cultivating Students' Critical Thinking in Middle School Physics

### 2.1. The Unique Advantages of Physics in Cultivating Students' Critical Thinking

As a fundamental discipline in empirical science, physics teaching has unique advantages in cultivating students' critical thinking abilities. The disciplinary characteristics of experiential science determine that students can acquire knowledge through science education, but they are not just acquiring knowledge and related skills. They also try to integrate the acquired knowledge to form a lasting attitude. In this way, when they face new problems, they will use critical thinking to analyze and solve them. This attitude of scientific thinking is a critical, exploratory, and experimental attitude.

In addition, physics is a vast and profound discipline, and it is very difficult to select the most valuable and suitable essence from a vast sea of knowledge to teach to students. Only by conducting a detailed analysis of the structure and characteristics of the discipline of physics itself can we select the things that best reflect the essential laws of physics. In this process, methods and approaches are particularly important, and how to enable students to systematically master knowledge is also a very important topic. Based on the above characteristics of physics, the cultivation of critical thinking ability has become a necessary path for learning physics. The benefits of critical thinking are multifaceted, including enhancing students' creativity and innovation awareness, enhancing problem-solving abilities, expanding scientific perspectives, and strengthening logical thinking abilities. Students with this ability are usually good at analyzing and evaluating solutions to scientific problems, and are able to think more deeply about complex problems.

## 2.2. Middle School is an Excellent Period for Cultivating Critical Thinking

Middle school students are in a golden period of physical and mental development, and they have a strong curiosity and thirst for knowledge. Middle school students generally have a wide range of interests and undergo significant physical and mental changes compared to elementary school students. They are the most receptive to new knowledge. On the other hand, their endurance, comprehension, abstract thinking ability, and independent operation ability are all in a gradually improving stage. At the same time, the psychology of middle school students has become more mature, and their cognitive development is in the stage of "formal operation". This is also a good opportunity to cultivate critical thinking, a high-level thinking. For example, experiments are a major platform for cultivating students' creative thinking, and physics teaching cannot do without experiments.

Many students, when learning physics, have a thinking pattern that is either right or wrong, and they habitually imitate it. This is because the teacher did not train students in critical thinking in teaching, resulting in a lack of profound understanding of physics concepts and laws, as well as a lack of problem awareness, evidence awareness, and logical awareness. They are not good at independent thinking. When facing problems, they usually cannot analyze based on evidence, make rational judgments based on logic, and are not good at thinking from different perspectives. All of these require critical thinking to complete.

# 3. Methods for Cultivating Critical Thinking Abilities

To implement the cultivation of critical thinking ability in physics teaching, it is necessary to cultivate the habit of critical thinking in questioning, improve the ability of critical thinking in exploration, and improve the quality of critical thinking in practical application. For example, in the classroom, educators can use heuristic teaching methods to guide students to think deeply about problems, and can also assist teaching through demonstration experiments. These can not only stimulate students' interest in learning, but also cultivate their hands-on ability, allowing them to understand why experiments are designed in this way on their own? Are there any issues or shortcomings? How to propose one's own solution, etc. Based on our teaching practice experience, we have summarized the following effective methods.

## 3.1. Create a Scenario to Trigger Questioning

The questioning of authority, the questioning of habitual things, and the questioning of known things are important manifestations of critical thinking. Asking questions is a manifestation of active thinking and also the beginning of independent thinking. So, in practice, it is important to cultivate the habit of critical thinking, which is generally problem oriented. Questioning based on practical problems is the foundation of critical thinking. Just like how a person's mind, soul, and spirit cannot survive without their body, a vivid question can stimulate students' curiosity. In the process of understanding problems, students will have doubts, which is the starting point for cultivating critical thinking.

For example, in the teaching of the course of synthesis and decomposition of motion, the following scenarios can be created. A ship leaves the port and enters the river. Its destination is the opposite pier. If it always keeps its bow facing the opposite bank, do you think it can reach the opposite pier? This situation triggers a series of thinking for students: if possible, why? If not, will the ship reach upstream or downstream? Teachers can provide several answers for students to critique and refute possible conclusions, thereby triggering their thinking.

This method requires teachers to explore and discover more in daily life, accumulate some common materials, especially those with strong interest and thinking, and then organize and process them, ultimately extracting them for students to refer to and learn from. Because real situations are often multidimensional and complex, when presenting situations to students, it is important to grasp the main contradictions and enable them to think better.

## 3.2. Highlighting Contradictions and Promoting Thinking

When the original cognitive structure is inconsistent with the actual situation, people will experience psychological contradictions and conflicts, and some conflicts that cannot be explained by the original cognition will prompt students to further think.

For example, when learning buoyancy, create the following scenario. Put a relatively light object into an empty beaker and slowly pour water into the beaker. Please think about whether the object is suspended in water or floating on the surface of the water? In the face of this question, students rely on their own cognition to believe that objects are suspended in water. However, it can be found through experiments that objects will float on the water surface. At this point, there is a significant conflict between the experimental phenomenon and the student's cognition, and the student's curiosity and thirst for knowledge towards the problem will also reach its peak. In this situation, conflicts that cannot be explained by the original cognition will prompt students to think, allowing them to discuss, refute, and exchange ideas with each other. Then teachers can use theoretical knowledge to explain and use a combination of theory and practice to help students master the knowledge. Cognitive conflict is the driving force behind the development of critical thinking.

## 3.3. Student Centeredness and Self-Improvement

Sharing questioning refers to placing students in the main position of the classroom and encouraging them to participate more actively. Through the role transition between teachers and students, collision of thinking can be triggered in the process of sharing questioning, thereby improving one's own thinking ability. Critical thinking teaching is a systematic and open teaching form.

For example, when exploring the influencing factors of sliding friction, teachers can first create scenarios of contact surfaces with the same pressure but different roughness levels, allowing students to study the relationship between the magnitude of sliding friction and the roughness of the contact surface. Through group collaboration, summarize that the magnitude of sliding friction is related to the roughness of the contact surface, and further explore the proportional relationship between them through processing of experimental data. Then ask students questions about what else the magnitude of sliding friction may be related to? What kind of experimental phenomenon would occur if the contact surface was changed to a contact surface with different pressures and the same roughness? Encourage students to

think and encourage them to make bold guesses and have the courage to verify their hypotheses through experiments. Through this process of comprehensive understanding, students will experience a certain improvement in their ability to analyze and solve problems comprehensively. In this teaching process, in addition to providing appropriate guidance and setting doubts, teachers should also emphasize to students the physical method used in studying this problem, the "control variable method", so that students can understand and be familiar with it. "Control variable method" is one of the commonly used experimental exploration methods in physics, thereby cultivating students' scientific thinking and rigorous logic.

Physics is closely related to daily life, and while acquiring relevant knowledge, students also develop their own opinions on various phenomena that arise in life. Some of them can be explained using existing knowledge, while others require theoretical deduction and supplementation with new knowledge to obtain answers. Throughout the process of explanation and analysis, students' thinking extends vertically and ultimately reaches the sublimation of their own thinking.

### 3.4. Cleverly Leaving Blank Space and Burying it in the Heart

Blank space is a common teaching method that usually appears at the end of a class or at the end of a learning project. It is a continuation of classroom teaching and can stimulate students to constantly think and learn. For example, in the teaching case of friction mentioned above, at the end of the class, students can be asked about their gains from this lesson, and then ask the question: "What are some examples of using friction in life? What are the ways to increase friction? What are the ways to reduce friction?"

Good blank spaces can be used to encourage students to actively review what they have learned and acquire new knowledge through questioning. In the collision between new and old knowledge, it is possible to continuously expand the training of students' critical thinking ability in time and space. In addition to questioning, blank space can also be experimental phenomena with strong sensory experiences, interesting scientific histories or character stories, current news hotspots, etc. Finally, through the clever design of blank spaces, cultivate students' critical thinking ability.

## 4. Epilogue

Critical thinking is an important skill that high school students urgently need to cultivate. It can transform students' thinking patterns, cultivate good learning habits, thereby improving their thinking and cognitive levels, and effectively promote the progress of middle school physics teaching. As guides, if teachers want students to break free from the bad study habits of painting the ground as a prison and sticking to conventions, the first thing they should do is to lead by example. They should not slack off or be limited to narrow knowledge in books. They should have more courage than students to explore and practice. In the future teaching process, high school physics teachers should break tradition, encourage students to actively participate in scientific exploration activities, encourage them to boldly ask questions, use various methods to solve problems, and effectively cultivate their critical thinking abilities.

## References


[1] Yu Lijun The cultivation of critical thinking in middle school physics teaching [J] Physics teacher, 2003.

[2] Zhang Lei The cultivation of critical thinking ability in middle school physics teaching [J] Reference for Middle School Physics Teaching, 2013.

[3] Xing Xing, Ren Xincheng Research on Introducing Critical Thinking into Middle School Physics Experimental Teaching [J] Modernization of Education, 2019.

[4] Wu Xiaobei The New Dynamics of Critical Thinking Theory, Teaching and Evaluation Research [J] Journal of Yan'an University (Social Sciences Edition), 2023.

[5] Sun Longzhou The connotation, value, and innovative cultivation path of critical thinking [J] High School Physics, 2023.