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Physics Experiment Teaching Based on Deep Learning

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Abstract: *The development of science and technology is an important means to enhance the comprehensive national strength. Therefore, it requires us to attach importance to the cultivation of scientific thinking ability. Physical experiment teaching is the basic content of physics teaching in middle schools and is an important way to cultivate students' spirit of study and science. However, at present, the importance of physics classroom experiment teaching has not been paid attention by many front-line teachers. This paper is based on the research status of deep learning and physics experiment teaching at home and abroad. Through the questionnaire survey, we can understand the implementation of experimental teaching for junior high school students. Combined with the specific cases of junior high school teaching, carry out experimental innovation, including the optimization of classroom experimental teaching aids and experimental methods, as well as the extension of students' family experiments after class. Through the test and comparison, the experimental scheme with strong feasibility is summarized to improve students' scientific thinking ability. I hope to provide new teaching ideas for other physics experiment teaching and make physics experiment become a good carrier for cultivating students' scientific spirit and improving their inquiry ability.*

Keywords: *Scientific thinking, deep learning, physical experiment*

1. Introduction

With the development of economy and social progress, the society has put forward higher requirements for talents, and the demand for scientific and technological talents is increasingly fierce. The core quality with scientific thinking as the core has become the era proposition of current education. The core qualities mentioned in the physics curriculum objectives include physical concepts, scientific thinking, scientific inquiry, scientific attitude and responsibility. However, under the influence of traditional exam-oriented education, in actual teaching, many teachers use video playback and teacher explanation to replace actual hands-on practice, ignoring the importance of leading students to explore the process of experiment. Deep learning requires students to pay attention to the understanding of physical concepts and principles, not only combining various chapters of physical knowledge, but also connecting physics with relevant knowledge of other disciplines to deepen understanding. The deep study of physics is closely related to the improvement of physics core literacy. This topic is based on in-depth learning to carry out innovative experiments, explore effective training strategies, let learners turn from surface learning to in-depth learning, and promote the improvement of students' core physical literacy.

Under the serious influence of one-sided pursuit of the enrollment rate of the secondary school entrance examination, most of the experiments were not displayed in the classroom. In order to catch up with the teaching progress, the phenomenon of "reciting experiments before exams" is widespread and difficult to eliminate (Suo Jianbiao, 2011)[1] .In his article, Yang Xiaochun clearly explained the relationship between experimental inquiry and in-depth learning and put forward corresponding training methods, such as guiding students to expand the research content of the experiment, encouraging students to develop questioning spirit and learning to choose topics for research(Yang Xiaochun, 2019)[2].Deep learning refers to the learning that, on the basis of understanding, learners can critically learn new ideas and facts, integrate them into the original cognitive structure, connect with many ideas, and transfer existing knowledge to new situations, make decisions and solve problems(Zeng Mingxing, 2015)[3].The National Research Council Panel (NRC) of the United States believes that deep learning is a process in which individuals apply their knowledge from one situation to another that is transfer(Bu Caili, 2016)[4].Zhang Hao and Wu Xiujuan believe that "deep learning requires learners to master unstructured deep knowledge and carry out critical high-level thinking, active knowledge construction, effective transfer application and real problem solving, so as to achieve the development of high-level abilities

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such as problem-solving ability, critical thinking, innovative thinking, metacognitive ability"(Yang Qing, 2018)[5].From the perspective of 21st century skills, NRC and Hewlett Foundation divide deep learning ability into three areas, namely, cognitive field, interpersonal field and personal field, and six abilities(Chi Jiahui, 2019)[6].Based on Piaget's cognitive development theory, J.B. Biggs studied the evaluation of deep learning results and proposed the SOLO theory. His evaluation model of learning process has been widely recognized and applied by researchers. "The first three levels of SOLO level, namely, the former structure, the single-point structure and the multi-point structure level, only involve changes in the number of knowledge and are shallow learning results; the latter two levels, namely, the correlation structure and the abstract extended structure level, change in the quality of knowledge, and the learning results have personal significance and reach understanding, and are deep learning results(Gao Zixiang, 2019)[7].The book "Deep Learning:7 Powerful Strategies for In-Depth and Longer-last Learning", co-authored by Leann Nickelsen, summarizes a deep learning cycle, namely the seven steps to achieve deep learning(Liu Haiyang, 2019)[8].

2. Research questions

According to the data, most of the relevant literatures on the cultivation of creative thinking ability belong to the more universal theories and methods. There are not many training programs for the physics enlightenment stage in middle schools. This research hopes to find more practical, more grounded programs that can let front-line teaching staff practice and apply through in-depth learning and physics teachers' innovative physics experiments, so as to cultivate students' creative thinking ability.

(1) What are the aspects of scientific thinking ability in physics teaching?

(2) What is the current situation of scientific thinking ability of students and teachers in the field of physical experiment teaching?

(3) In the field of physics, how do middle school students cultivate their scientific thinking ability through deep learning and experimental exploration?

3. Methodology

3.1 Research object

Taking a middle school as a case school, we identified the students, physics teachers and school participants from two classes in Grade 9 of junior high school as the research objects.

3.2 Data collection

The materials involved in this study include the acquisition of questionnaire measurement data and interview data of students and faculty. Quantitative analysis is used for questions 1 and 2, and qualitative analysis is used for question 3. The first stage: conduct a questionnaire survey on the students and staff of the ordinary and key classes. The second stage: conduct preliminary training for experimental teachers and carry out educational experiments. After that, the data of students and staff in regular and key classes were collected again and empirical research was conducted.

3.3 Research method

This study first queried a large number of relevant documents on in-depth learning and scientific thinking on CNKI, including connotation, influencing factors and effective ways and methods for improvement. Through literature research, establish the structural model and theoretical basis for deep learning and effective improvement of scientific thinking of middle school students. Through the questionnaire survey, we can understand the current situation of middle school students' scientific thinking, their attitude towards scientific thinking, and the current situation and problems of teachers' training in this field. Through data analysis, we can obtain the current level of physical literacy of middle school students. Find out the weaknesses and challenges faced by middle school students in the cultivation of scientific thinking ability in the field of physics, and then take this as a guide, we will evaluate 26 middle school physics exploratory experiments, and list the areas that need to be improved when evaluating their shortcomings. Take the physics teaching and research group as a unit, discuss and further strengthen the simplification, standardization and diversification of the obvious operation of experimental phenomena. Combining the theory and practice of deep learning, the improved physics experiment is properly integrated into the physics class, and the experimental teaching design is optimized, so as to guide teachers and students to learn, experiment and think deeply together. Use weekends and holidays to guide students to use objects and equipment around them to design experimental plans, experimental steps and experimental implementation. Cultivate the process of students' observation and summary, so as to improve students' scientific thinking awareness and ability.

4. Discovery process

Scientific thinking is a way of understanding the essential attributes, internal laws and mutual relations of objective things from the perspective of physics; It is the abstract generalization process of constructing physical model; It is the specific application of analysis, synthesis, reasoning and demonstration methods in the scientific field; It is the character and ability to question and criticize different information, opinions and conclusions based on factual evidence and scientific reasoning, test and revise them, and then put forward creative opinions. Scientific thinking mainly includes model construction, scientific reasoning, scientific argumentation, questioning and innovation and other elements.

Change teachers' teaching thinking and break traditional teaching barriers. In the physics experiment course, teachers often use teaching aids to demonstrate experiments, and use multimedia to show students how to learn, so that students can "learn in teaching" gradually cultivate students' deep learning habits. To cultivate students' scientific thinking, it is necessary to break the traditional "waiting" learning and guide students to in-depth learning. In order to cultivate students' scientific thinking ability, teachers should hold the "decision-making power" in the hands of students. Cultivate students' deep learning habits and let them boldly do, ask, think and solve. In the experiment class, students should not be afraid of any situation and can deal with any unexpected situation in the experiment. Carry out stratified teaching experiments to create a positive learning atmosphere.

It is divided into two levels according to comprehensive performance, learning ability and hands-on practice level. The general class (Class 93, Class 910) is the first level, and the students' comprehensive learning ability, understanding ability and practical ability are average. The experimental class (Class 92, Class 911) is the second level. Students at this level have strong comprehensive learning ability, understanding ability and practical ability. Teachers take different teaching tasks and methods according to different learning levels, so as to select experiments and problems with different difficulties, so that different students can feel their sense of belonging in the physics class. For example, this topic takes series and parallel as case teaching, as shown in Table 1.

Table 1. Comparison diagram of case teaching of Parallel and Series

Ordinary class		**Experimental class**	
Class 93	Class 910	Class 92	Class 911

For students in ordinary classes, the teacher designed simple question strings to trigger students' initial thinking, so that students can gradually aspire to explore their own answers in the questions. Let students start from simple series to carry out experimental exploration. After students have mastered the basic essentials of series through independent inquiry, students' enthusiasm in the classroom has been fully mobilized at this stage, and then try to improve the difficulty of exploring the characteristics and judgment of parallel, In this design stage, students can be greatly stimulated to realize their self-worth, so as to improve their ability.

For students in the experimental class, teachers should have higher requirements according to their abilities. After allowing them to explore the characteristics and connection methods of series and parallel connection through independent experiments, teachers should design some simple obstacles on the basis of mastering basic experiments to improve their ability to apply knowledge and solve problems. Then it can improve the difficulty, so that students can use classroom experimental equipment or living equipment, try to design circuit connections with application value, and conceive practical fields that can be used in life. The design at this stage can greatly improve the students' ability to combine physical experiments with life. Through the classroom to experiment, and then pull the distance to life, students can cultivate their comprehensive development ability of active exploration and love of thinking.

Traditional experimental teaching methods: Class 93 and Class 910. In the classroom, the teacher uses the teacher's tools to demonstrate the connection of simple series and parallel circuits to the students. According to the teacher's demonstration process, guide students to summarize the characteristics of series and parallel circuits. Then a simple life design experiment was conducted in Class 93, and a life

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design experiment with certain difficulties and obstacles was designed in Class 910. Let students apply the theoretical knowledge of this experimental lesson to their daily life, as shown in Table 2.

Table 2. Class comparison with innovative teaching method

Traditional teaching		**Innovative teaching**	
Regular class	Experimental class	Regular class	Experimental class
Class 93	Class 92	Class 910	Class 911

Innovative teaching methods: Class 92 and Class 911. In the classroom, teachers only present their goals and guide their task strings. All other inquiry processes and task-based experiments let students operate by hand and draw corresponding conclusions according to what they have done, thought and thought. Summarize the key points of the class through the experimental students. Then put forward the same life design experiment and observe the students' operation results.

Through comparative experiments, it is found that students at ordinary and experimental levels can accurately express the characteristics, differences and other basic knowledge of series and parallel circuits in classes with two different modes, and the completion rate is not much different, as shown in Table 3.

Table 3. Completion rate of basic knowledge of ordinary class and high-quality class

arrangement	**pattern**	**class**	**Number of people**	**Total number of people**	**Completion rate**
ordinary	tradition	Class 93	39	50	78%
	innovate	Class 92	41	50	82%
experiment	tradition	Class 910	49	50	98%
	innovate	Class 911	47	50	94%

In the experimental stage of life design, the class completion rate of traditional teaching methods is significantly lower than that of innovative teaching methods. In the general level, the completion rate of 93 classes of traditional mode teaching is 50%, and the completion rate of 92 classes of innovative mode teaching is 78%; In the experimental level, the completion rate of Class 910 in traditional mode teaching is 80%, and that of Class 911 in innovative mode teaching is 94%, as shown in Table 4.

Table 4. Completion rate of life experiment design in ordinary class and high-quality class

arrangement	**pattern**	**class**	**Number of people**	**Total number of people**	**Completion rate**
ordinary	tradition	Class 93	25	50	50%
	innovate	Class 92	39	50	78%
experiment	tradition	Class 910	40	50	80%
	innovate	Class 911	47	50	94%

5. Results

The comprehensive results show that the innovative experimental teaching mode is more conducive to cultivating students' quality and ability of scientific thinking, such as model construction, scientific reasoning, scientific argumentation, questioning and innovation. Compared with the traditional experimental teaching mode, its advantages are more prominent. The study found that compared with the traditional experimental teaching mode, students at the same level have higher learning completion under the innovative teaching mode.

6. Discussion

Through data analysis, students at different levels will teach in different modes. Data can obviously be fed back. Under the innovative teaching mode, students at all levels can achieve different levels of ability improvement, especially in the application of knowledge. In addition, through the actual presentation of the classroom, the classroom atmosphere under the innovative experimental teaching mode is significantly more active than that under the traditional mode, and students think that the classroom interest is significantly enhanced.

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7. Conclusion

According to the curriculum standards, we purposefully improved and innovated the ordinary experimental teaching, made the abstract dogmatic experiment vivid, made the experimental phenomenon bigger, easier to watch or more wonderful to present, and made the experimental operation easier to operate and complete. Let students participate in more experiments, experience and understand the experiment. Secondly, in teaching, there are many disordered methods that enable students to study deeply, enable students to study physics actively, interestingly and thoughtfully in experimental exploration, deepen students' understanding of physical concepts, improve students' scientific thinking, cultivate students' scientific literacy, and improve students' scientific quality, exploration spirit, innovation awareness and other comprehensive qualities.

This topic discusses how to combine deep learning with innovative physics experiment teaching through various methods, which is conducive to cultivating students' scientific thinking ability. However, the exploration of this topic also has its limitations. It is only within the scope of physics, and the exploration of other disciplines needs further discovery.

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