

# Research on Innovative Application of Maker Education in Middle School Physics Experiment

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## Abstract

With the popularization and development of the Internet, primary and secondary education has undergone earth-shaking changes. The concept of "maker" has been introduced into China. As an innovative activity, the movement of creation can make children diverging their thinking, stimulate their interest in creation, and cultivate their innovation ability and practical ability. By applying maker education to physics experiment teaching in middle school, students can not only learn relevant knowledge in the field of physics experiment, but also meet their needs for other knowledge. Physics experiment in middle school is an important carrier of cultivating students' innovation ability. The integration of maker education idea into physics experiment is beneficial to cultivating students' innovation ability.

## Keywords

Maker Education; Middle School Physics Experiment; Stimulate Creativity.

## 1. The Introduction

### 1.1. The Status Quo of Maker Education

Overseas, since 2013, more and more primary and secondary schools in the United States have joined the "Maker Action" to implement "Maker education" and regard "Learning by Making" as the way students really need to learn. In China, the concept of "maker" was introduced into China around 2011. The Chinese government supports the development of maker education, and the atmosphere for the great development of maker education is gradually forming. In his review of the work of 2014, Premier Li Keqiang said that Internet finance rose to prominence, e-commerce, logistics, express delivery and other new forms of business grew rapidly, many "makers" came to the fore, and cultural and creative industries flourished. At the executive meeting of The State Council in early 2015, Premier Li Keqiang proposed to "improve the entrepreneurship guidance system, support the holding of entrepreneurship training camps, entrepreneurship and innovation competitions and other activities, foster a maker culture, and make entrepreneurship and innovation become a trend".

### 1.2. Research Background of Maker Education in Middle School Physics Experiments

At present, "Maker Spaces" and "maker" courses have also made progress in many primary and secondary schools. There are now more than 2,000 makerspaces around the world, and the growth rate is very fast. With the development of Internet technology, a wave of maker education has been set off in the field of education, aiming to effectively solve the drawbacks existing in the current primary and secondary education, such as lack of innovation ability, to ensure that students can be guided to acquire necessary learning knowledge through independent hands and thinking, and truly achieve the teaching goal of "learning by doing". Since physics is an experiment-based discipline, there are certain requirements for students' hands-on and practical abilities. The teaching methods and methods of maker education are of great help to the teaching of physics. Therefore, integrating maker education

into middle school physics experiments is a new way of learning experience for students and a new form of teaching for teachers. The main purpose is to let students look at problems from a perspective of development and understand that physics is developing and technology is progressing.

## **2. The Purpose and Significance of Maker Education in Middle School Physics Experiment Innovation Application Research**

At present, with the popularization and development of the Internet, primary and secondary school education also changed dramatically, course content become more rich and colorful, multimedia, and across the country to enhance students' ability of facing the 21st century, tracking international to a new generation of information technology leads the trend of the development of education reform, the rise of education as a guest, In the field of basic education, the research on the construction of makerspace and the implementation of maker curriculum has also achieved good development and progress. With the development of maker movement globalization, maker education and Internet technology interaction and integration, set off a wave of teaching reform in the educational circle. Creative movement is an innovative activity, which can let children divergent thinking, stimulate their interest in creation, and cultivate their innovative ability and practical ability.

### **2.1. The Teaching Reality of Maker Education in the Innovative Application of Physics Experiments in Middle Schools**

Maker education has the important feature of interdisciplinary, which involves a wide range of knowledge and provides students with many application references for learning. By applying maker education to physics experiment teaching in middle school, students can not only learn relevant knowledge in the field of physics experiment, but also meet their needs for other knowledge. In middle school physics experiment teaching, the maker education provided by teachers is a breakthrough of traditional teaching ideas and a respect for students' comprehensive development. In the classroom, students can use their physics knowledge to solve the existing knowledge problems, but also can effectively integrate all kinds of resources, to achieve mastery of knowledge.

### **2.2. Educational Value of Maker Education in Innovative Application of Middle School Physics Experiment**

Physics experiment in middle school is an important carrier of cultivating students' innovation ability. The integration of maker education idea into physics experiment is beneficial to cultivating students' innovation ability. Both students and teachers play the same roles in maker education and middle school physics experiment, and the teaching objective of maker education and middle school physics experiment is the same, which is to improve students' innovation ability. Therefore, it is feasible to implement maker education in middle school physics experiment. Maker education should be integrated into middle school physics experiments. Teachers should not only teach experimental content and explain High-end technology, but also develop new teaching resources and organize physical activities such as science and technology production in the experiment process, so as to make the integrated teaching of middle school physics inquiry experiment and maker education more perfect through various measures. High school physics teacher should through the education and the depth of the physics experiment teaching integration, especially through the effective intervention of information technology in the concept of a guest, lead the students more creative, more "creation", more relaxed but more efficient experiment, creating autonomy, openness, flexibility and innovative new physics experiment teaching time and space.

### **3. Innovation and Breakthrough of Maker Education in Middle School Physics Experiment Innovation Application Research**

#### **3.1. Break through the Traditional Physics Experiment Teaching Method and Integrate the Maker's Concept of "Learning by Doing"**

Experiment teaching is an important part of physics, experiment can stimulate students' interest in learning physics, improve students' initiative in learning physics. Middle school physics experiment is of great help to cultivate students' innovative ability, innovative spirit and innovative consciousness, so that students' ability to use their hands and brains has also been greatly improved. The essence of maker education is the process of making real objects out of students' creativity through the superposition of knowledge and technology, which is similar to the teaching purpose of physics. Middle school physics teaching has been hoping that students to achieve the degree of learning for use, but because of the way of our country now exam-oriented talent selection, more physics teachers just teach knowledge, for the training of practical ability or lack of, therefore, in the physics classroom to increase the number of experiments is particularly important. Because maker education requires students to be more innovative than middle school physics experiment, it is feasible to integrate maker education with middle school physics experiment.

#### **3.2. Students Play a Leading Role in the Innovative Application of the Maker Concept in Middle School Physics Experiment**

Maker education is a process in which students discover and solve problems by themselves. Therefore, students mainly play the role of creator and discoverer in maker education. In physics inquiry experiment, for example, high school physics inquiry experiment is put forward by physics teachers, and by the students guess hypothesis, design experiments, through the paper summarizes the experimental phenomenon, evaluation process of communication, so in the teaching process, the physics teachers need to create a good physical environment for students, so that the students in such an environment for physics experiment operation, In the process of students' independent inquiry, students are not only the creators of experiments, but also the discoverers of physical phenomena. In maker education and physics experiments, students play the same role. However, the sources of problems are different. Maker education is about students actively discovering problems in their own environment, while middle school physics experiment is about questions raised by physics teachers. Therefore, middle school physics experiment is more passive than maker education. If in the middle school physics experiment, the teacher introduces the theme of the lesson to the students and allows the students to verify the problem through their own environment, it is also a new way of physics teaching. The advantage of doing this is that it can better reflect the students' subjectivity in teaching, and can well mobilize students' enthusiasm for learning physics, so that students can observe the world more carefully, and prepare for students' long-term development.

#### **3.3. Teachers Play a Guiding Role in the Innovative Application of the Maker Concept in Middle School Physics Experiment**

For maker education and middle school physics inquiry experiment, teachers are definitely not bystanders in the process of asking students to take the initiative to solve problems. For a guest education, in the process of students to find and solve problems, first of all should have a certain amount of theoretical knowledge as well as some High-end technology (3 d printing, laser cutting machine and other modern technology) knowledge and method of use, this can't be lack of teacher's explanation, and in the process of students found the problem, If students encounter knowledge beyond their ability, teachers should promptly explain and guide. For high school physics experiment, the students in the process of experimental operation could

not be smooth sailing, the difficulty of solving process is a good way to improve student ability, teacher don't directly to explain, but for this problem to bear, let the student through the guidance of teachers have a sense of an Epiphany, this is the effective experimental teaching. Therefore, in maker education and middle school physics experiment, teachers are in the position of guider, which makes it possible to integrate the teaching of the two.

## **4. The Main Idea of Maker Education in Middle School Physics Experiment Innovative Application Research**

### **4.1. Philosophy: Teachers Change the Traditional Educational Ideas from One-way Indoctrination to Man-machine Integration**

In order to truly integrate the maker education concept into middle school physics experiments, physics teachers are required to change the traditional teaching form and implement maker education to change their thinking. In maker education, teachers need to change their traditional teaching ideas and become guides for students to learn. To achieve such a classroom, teachers need to keep learning and researching. In physics experiment teaching, students are no longer passive listeners, but the masters of the classroom. They can explore problems and acquire updated knowledge, and connect with information technology to achieve knowledge integration.

Under the background of maker education, teachers change from One-way indoctrination to Man-machine integration, make full use of information technology, play with information technology, and students' Man-machine integration and two-way interaction, naturally learning is full of flavor, and they go further and gain more in the kingdom of physics. In more physical experiments and more huMan-machine integration, the "playing with information technology" emphasized by maker education plays a very important role in the process. Practice has proved that the middle school physics experiment needs the maker idea and the deep intervention of maker technology. Perhaps the amount of technology applied is not the most important thing. In this process, students' interest is stimulated, their vision is broadened and their thinking is active, which is what maker education needs more. Therefore, teachers need to reconstruct the framework and path of physics experiment teaching to build a bigger stage for the improvement of students' thinking ability and innovation ability.

### **4.2. Practice: Encourage Students to Carry out Creative Activities from Single Presentation to Multi-contrast**

Practice is the basis for acquiring all knowledge and cognition. In physics experiment teaching, teachers should create certain independent learning space for students, so that students can use the knowledge they have learned to think and explore in combination with other problems discovered by themselves, and then apply maker education to physics experiments. In continuous thinking and learning and creation, students will have a broader thinking and a higher success rate of creative activities. For middle school students, their inspiration comes quickly, once students have a creative time, teachers should provide students with better learning resources and materials, to meet the curiosity of students to participate in practice, let them enjoy their wisdom.

Therefore, teachers should present to multiple contrast from a single, leading students to be more creative, more harvest. For example, in the experiment of exploring "magnetism generating electricity", the digital technology is used to present the magnetic field with virtual magnetic induction lines, and the phenomenon of conductor moving in different directions is compared so that students can quickly understand the principle. The comparative presentation of maker technology can activate students' interest in learning, promote them to master some

knowledge points more quickly, and finish the projects they are interested in seriously, actively and actively, so as to acquire new skills and create new things.

#### **4.3. Experience: Enhance Students' Knowledge Application Ability from "Obscure" to "Easy"**

The ultimate purpose of learning knowledge is to apply it to life and solve various problems in life. Introducing the idea of maker thinking into physics experiment teaching is not only a basic respect for students' dominant position, but also a process to stimulate students' imagination and association, as well as their thinking ability and knowledge application ability. Therefore, in the middle school physics experiment teaching, teachers should design for students and life closely related problem situation, stimulate students' interest in learning and thinking ability, let students make full use of the knowledge to carry on the connection between problems, so as to solve the problems in physics experiment teaching. Based on this, physics teachers should make full use of maker technology and digital equipment to optimize the learning process and add value to physics teaching. Of course, students go from being "hard to understand" to "easy to learn", making learning easier and more productive. This process should become an important point of view for the deep integration of maker education and physics experiment teaching in middle school.

### **5. Implementation Plan for Innovative Application of Maker Education in Middle School Physics Experiment**

#### **5.1. Integrate the Cutting-edge of High-end Science and Technology into the Middle School Physics Inquiry Experiment**

Due to the historical background of maker education, students should be informed of Cutting-edge knowledge of science and High-end physical technology in the process of teaching physical inquiry experiments. Students' ability cultivation should be achieved step by step rather than in one step. Through the explanation of High-end science and technology, students can have some understanding of the development of physics, which can not only increase the breadth of students' knowledge, but also enable students to draw inferences by analogy, and start their own thinking to create new things. The explanation of High-end science and technology puts forward higher requirements for teachers. First of all, teachers should have a certain understanding of the forefront of science and High-end technology, which has certain requirements for teachers' usual reading. Secondly, teachers should explain High-end technology step by step in the process, the High-end technology should be consistent with students' knowledge and ability level, not too boring and complicated explanation, so that students will be bored before learning; Finally, when teachers explain High-end technology, they should combine it with real life, which will make students feel like they are in it and make them find physics is not far away. The frontier of High-end science and technology is unfamiliar to most students. Therefore, teaching the knowledge of High-end science and technology in physics class will be of great help to students in learning physics, and they will pay more attention to physics in real life.

#### **5.2. Develop New Teaching Resources in Middle School Physics Experiment Teaching**

In the middle school physics experiment course development process, not only to improve students' innovation ability, but also to improve teachers' innovation consciousness, so the higher the teacher's innovation consciousness, innovation spirit, students' innovation ability and thinking will have a great improvement. In physics experiment teaching process, teachers should be as much as possible to develop experimental instrument, if the use of the students

show the simple things around physical phenomena, can make students more believe that the generation of laws of physics and the development, also can make students more carefully observe their surroundings, and to discover and solve problems, in this class is the effective way of developing students ability. In the process of physics experiment teaching, teachers should take the initiative to develop teaching resources, so that students can find problems and use knowledge to solve problems both in life and in study. At the same time, we should not forget that students are also exploitable teaching resources. Rationally developing students' teaching resources can increase their learning experience, improve their innovation ability and develop their thinking.

### 5.3. Properly Infiltrate Science and Technology into Physical Experiments

Small production of science and technology can cultivate students' practical ability, thinking ability and scientific attitude. Science and technology mini-production, science and technology competition, visiting science and technology exhibition and other activities for students are the process of learning physics from life and applying physics to life. Therefore, it is necessary to carry out physics mini-production, science and technology exhibition and other physical activities after class and encourage students to participate in science and technology production competition. Now there are some schools use students self-study time, carried out once a week technology course, and hired professional teachers to explain, theory of students in the class by the teacher's explanation, and the actual operation to extrapolate watch teachers for specific operation, students with such a course is full of interest, can also see students make all kinds of small production. There are many kinds of interesting after-school learning activities like this, and teachers should carry out more such activities to mobilize students' enthusiasm and make them study better.

## 6. Research Summary

High school physics teacher should through the education and the depth of the physics experiment teaching integration, especially through the effective intervention of information technology in the concept of a guest, lead the students more creative, more "creation", more relaxed but more efficient experiment, creating autonomy, openness, flexibility and innovative new physics experiment teaching time and space. More colorful, mysterious and magical physics experiments need to lead students to "cross those invisible boundaries", which cannot be separated from the change of teachers' teaching ideas, and cannot be separated from the efficient intervention and large-scale coverage of digitalization, information and intelligence in middle school physics learning. Because of the deep penetration of technology and associated ideas, lively ideas are at your fingertips, and innovative and creative activities become reality, which is exactly what maker education needs more. In this way, it will create a timely, efficient and wonderful new space and time of physics learning.

In recent years, China's major technologies continue to emerge -- large aircraft, quantum communication... "Innovation is the primary driving force for development," Xi said at the third session of the 12th National People's Congress in Shanghai. Innovation means development, and innovation means the future. The key to adapting to and leading the new normal of China's economic development is to rely on scientific and technological innovation to transform the driving force of development. "Therefore, teachers should train students' innovative ability, innovative consciousness and innovative spirit in the important position of teaching, in the training of students' innovative ability at the same time, but also to cultivate students' hands-on ability to infiltrate them, because we need practical innovation, rather than armchair innovation. To carry out maker education is to cultivate students' innovation ability, which is the process of materializing creativity. Therefore, it is necessary to infiltrate maker education into physics teaching. The development of physics experiment in middle school is helpful to

cultivate students' independence and innovation. It is an effective way to train students' innovation ability to design experiments by students alone. Therefore, maker education and middle school physics experiment are both a way to cultivate innovative talents, so there is a certain foundation for the integration of the two. For middle school physics experiments, maker education combines High-end technology and enables students to walk in the forefront of science and technology, which is of great help to the long-term development of students. It can not only enable students to learn theoretical knowledge of physics, but more importantly, help students to develop comprehensively. Therefore, It is a feasible new teaching method to carry out middle school physics experiment under the concept of maker education.

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