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A study of "Micro STEM" Physics Classroom Teaching

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ABSTRACT

This paper explores the “Micro STEM” physics classroom teaching from the two aspects of pre-class design ideas and teaching links, and conducts an investigation on the teaching effect of students after class. The study finds that “Micro STEM” classroom enables students to understand and use the target knowledge better than traditional classroom, and students’interest in learning and classroom participation are higher. It is helpful to cultivate students’ability to discover and solve problems and sense of teamwork, and to improve students’ core scientific literacy.

Keywords: Micro STEM; Physics classroom; Teaching inquiry; teaching evaluation

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STEM course is a comprehensive and interdisciplinary course which organically integrates science, technology, engineering and mathematics. It is of great help to foster students'ability to discover and solve problems, as well as scientific literacy, engineering and technical literacy, and comprehensively enhance the core competitiveness [1]. In 1989, the United States put forward STEM education for the first time, and in 2011 it was fully extended to the whole K-12 section [2]. With the rapid development and deepening of STEM teaching research, the seemingly vigorous STEM curriculum also faces many embarrassing problems in practical teaching. STEM course is a relatively implicit and slow process to improve students'scientific literacy. The effect of STEM course is closely related to teachers' classroom design[3]. Most STEM courses require a relatively long cycle to complete projects, such as one or two projects per semester. Although such projects can improve students'core literacy to a certain extent, they often waste more time due to the long project cycle and the inefficiency of the classroom. At the same time, it is difficult for students to achieve the integrity of the knowledge system in general teaching [4]. And many STEM learning is based on some fixed facilities such as 3D printer, robot module and other programming modules. Not only is there relatively more investment, but also there is a great pressure on ordinary schools with relatively tight funds, and teachers'teaching thinking is often limited by equipment, which can not really play the core role of STEM curriculum. Especially for the graduates who are under great pressure to enter higher education, they can not spare a lot of time for STEM courses [5]. Therefore, in order to solve the problems encountered by the traditional STEM curriculum and effectively improve the efficiency of classroom teaching, this paper puts forward the "Micro STEM" curriculum model and explores it.

"Micro STEM" course is a small and sophisticated STEM course which can be completed in one to two weeks based on STEM education concept. "Micro STEM" course not only contains the advantages of STEM education thought, but also is convenient for teachers to implement. It does not need to buy expensive equipment, and the classroom cost is low. The traditional STEM course is time-consuming, inefficient and incomplete knowledge system. This paper focuses on the study of physics "Micro STEM" classroom teaching, to provide some ideas for the reform of STEM curriculum.

1. Design of Physics "Micro STEM" Classroom

Teachers should design physics "Micro STEM" classroom in the following three aspects:

(1) To clarify the target knowledge and mastery level of the curriculum.

When designing the course of "Micro STEM" in physics, teachers should first make clear the target knowledge points of the course and the degree to which students should master it. Knowledge points start with the syllabus, try to make different "Micro STEM" courses for different knowledge points, reduce repetition and cover all the knowledge points required by the syllabus, thereby improving classroom efficiency and improving the knowledge system.

For the mastery of knowledge points, teachers need to consider the task of setting different difficulties in curriculum design. That is to say, the knowledge points with shallow mastery are required to pass by, and the knowledge points with deeper mastery are required to appear repeatedly in different forms in the curriculum, so as to highlight the key points.

(2) Designing micro-projects or creating micro-scenarios to achieve teaching objectives

The achievement of teaching objectives depends on the design of easy-to-operate micro-projects or the creation of reasonable micro-scenarios. STEM course is different from the traditional classroom in that it is mainly carried out in the way of project-based learning. Students take groups or even classes as units to master knowledge of different disciplines and improve their ability to discover and solve practical problems in the process of completing the project. The teaching process of "Micro STEM" is also based on projects, but it mainly uses the common tools and objects around it to design easy-to-operate micro projects or reasonable micro-scenarios, so that students can complete a project in one to two weeks or solve a practical problem.

(3) Establishing a reasonable evaluation mechanism

Courses without evaluation mechanism are incomplete and inefficient. Teachers must pay attention to the establishment of the final evaluation and assessment mechanism when designing courses. The evaluation of Micro STEM course is relatively flexible. According to the course content, it can report on project implementation, submit production results, and even write failure summaries.

2. Physics "Micro STEM" classroom teaching link

Classroom teaching is the key link to determine the success or failure of the whole course. Teachers should take the following five basic steps in teaching:

(1) Teachers'Teaching Plan and Arrangement

Teachers tell students about the problems they are facing and make clear the project plan. At the same time, students are grouped according to the difficulty of the project plan. There are fewer difficult project groups, more members in each group, more difficult project groups and fewer members in each group. At the same time, the group members should be collocated reasonably according to the characteristics of students.

(2) Free discussion and access to information within each group

After the project plan and objectives are clear, sufficient internal discussion and access time should be given to each group. Make each group have enough time to understand, analyze and design the implementation plan. During the internal discussion, teachers can participate in the discussion of each group and put forward some opinions, but do not evaluate the plans of each group.

(3) Discussing and exchanging among groups and improving plans

Although there is some competition among the groups, there is still a certain amount of time for communication and discussion among the groups. To enable students to better understand the relationship between competition and cooperation, learning to think about win-win mode.

(4) Student Implementation Plan

After defining the project plan and process, each group can start to complete the plan, then meet new problems in the process of completing the plan, and solve the problems by repeating (2), (3) two steps to complete the whole project.

(5) Completing the Evaluation of Students'Works

Students submit the completed project report or other assessment requirements. Teachers carefully analyze the content and score the groups, and put forward some follow-up improvement

suggestions.

The above five steps can be adjusted reasonably according to different tasks and learning conditions, and finally form a complete teaching process. Figure 1 below is the general teaching flow chart of "Micro STEM".

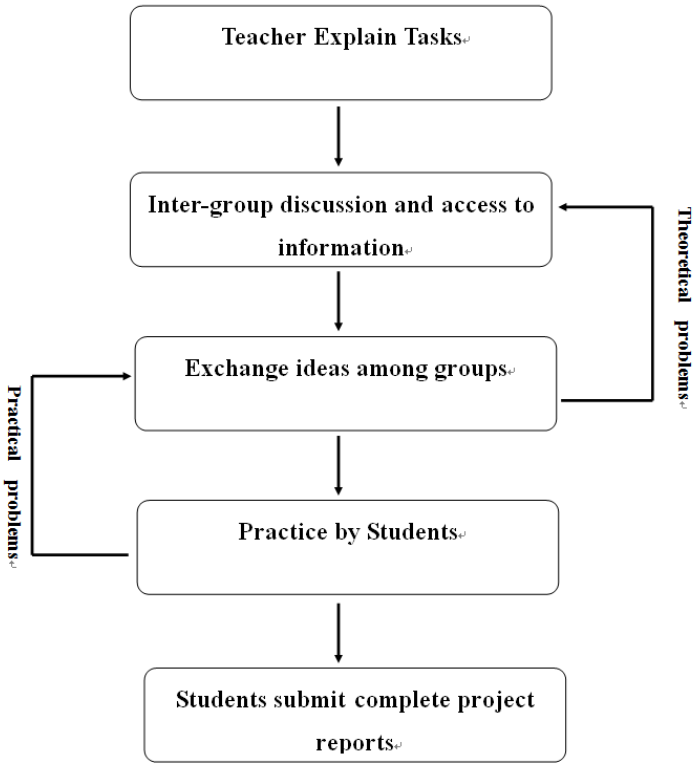

Fig. 1 General teaching flow chart of Micro STEM

3. Post-teaching Investigation and Reflection on Physics "Micro STEM"

At the end of the course, the author investigates the students who use the "Micro STEM" mode to teach classes and the students who use the traditional mode to teach classes from four aspects: interest in learning, mastery of knowledge, research methods learned and overall harvest. The results of the survey are shown in Table 1 below.

Teaching method	Interest in learning	Mastery of knowledge	Research methods learned	Overall harvest
Micro STEM	86%very interested	84%very clear	90%more than one	90% very rewarding
	10% interested	12% clear	6% one	10% rewarding
	4% less interested	4% less clear	4% none	0%less rewarding
Conventional teaching	68% very interested	76% very clear	56% more than one	62% very rewarding
	24% interested	24% clear	26% one	36% rewarding
	8% less interested	10% less clear	18% none	2% less rewarding

Table 1 Feedback Table of Teaching Effect

Research feedback shows that "Micro STEM" teaching can significantly improve students'in-

terest in learning knowledge, and make students change from passive receivers to active thinking constructors. This role change makes students have a deeper understanding of the original abstract concepts and a better understanding, especially the improvement of students'operational skills. Using the "Micro STEM" classroom, students can grasp more knowledge in a relatively free and relaxed atmosphere, promote the integration of disciplines, exercise the sense of cooperation and the ability to find and solve problems, which has a certain role in promoting the comprehensive development of students'scientific thinking.

Reflecting on the whole teaching process, students'participation and practice occupy most of the time. In order to achieve the goal, students have explored the application of knowledge in different disciplines. The depth of thinking and knowledge application have obvious advantages over the conventional classroom. But at the same time, it also exposes some problems, such as the unclear division of labor in some groups, and the phenomenon of relying on more prominent members with individual abilities. In view of this situation, we should have a clearer division of labor for various tasks, and pay attention to training students'usual sense of cooperation.

4. Summary

The application of Micro STEM in physics classroom teaching not only includes the advantages of integrating STEM with educational ideas, but also facilitates the operation of teachers and students. At the same time, the low-cost classroom will not cause excessive financial burden to the school. By carrying out multiple "Micro STEM" classes in one semester, students can effectively cover as many knowledge points as possible, improve their knowledge network, and flexibly apply the knowledge they have learned.

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