

Teaching Implementation and Improvement Direction of Student Science Experiments

-- Take “Weigh the Mass of Solids with a Balance” for Example

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Abstract: This article explores how to optimize the teaching design of the measurement experiment “Weighing the Mass of Solids with a Balance” in the context of the new middle school entrance examination, aiming to enhance students’ physical experiment operation ability and innovative thinking ability. The article points out that experimental teaching should combine the requirements of textbooks and new curriculum standards, pay attention to the design of experimental operation details, and stimulate students’ interest in scientific exploration through problem driven strategies. Specifically, in the chapter on “Measurement of Quality”, the knowledge sequence of the textbook includes the concept of quality, unit conversion, quality attributes, measuring instruments, and the use of scales. In teaching, it is necessary to pay attention to the initial use of scales, guide students to understand the structure and principles of scales, and attach importance to experimental operation training. In response to teaching difficulties, such as error analysis, measures should be taken to improve students’ understanding, such as through example analysis and strengthening guidance on experimental steps. In addition, the article also emphasizes the direction of teaching improvement, including adjusting the content position to optimize the learning process, segmenting teaching based on student learning situations, optimizing teaching methods, adding experimental report writing, encouraging communication and display, designing multi-level experimental tasks, and promoting the spiral increase of students’ scientific exploration ability through repeated experiments and problem guidance.

Keywords: Scientific experiments; Quality measurement; Teaching optimization

1. Overview of teaching content

“Measurement of Quality” is selected from Chapter 4, Section 2 of the Science textbook for seventh grade in Zhejiang Education Press. Measurement requires instruments, and students have mastered the basic methods of measurement through previous learning. They can provide simple explanations for some phenomena. But tray scales are relatively precise instruments that students use for the first time, and teaching should allow students to personally experience and perceive the design and structural principles of the scales^[1]. In addition, using a tray scale is a good time for students to operate it by hand. Seventh grade students are more active and have strong acceptance abilities. Through hands-on work, they can further promote their understanding of the structure of the scale, master the methods of using the scale, and improve their comprehensive abilities. Standardizing the use of measurement tools is a fundamental knowledge that is clearly required by the middle school science curriculum standards. It is a basic skill in daily life and an important part of experimental operations in the middle school entrance examination.^[2] Quality measurement is a type of physics experiment class that requires students to understand the principles and structures of measurement tools, and cultivate good experimental operation habits.^[3]

As the second section of this chapter, the first section explores the composition of matter from a micro essential perspective. Therefore, the learning objective of this section is to understand the characteristics of matter from the macro perspective of quality, laying the foundation for subsequent learning of concepts such as density and specific heat. It is necessary to pay special attention to experimental observation and hands-on operation, and use checklists and other performance evaluations to promote more targeted learning for students^[4]. The use process and measurement results of the tray balance are intuitive and easy for students to feel, but analyzing and discussing the error of the measurement results is a challenge^[5]. Therefore, students should also deepen their practice based on their understanding of measurement principles and experimental operations.

2. Textbook knowledge order

The knowledge presentation order of the Zhejiang Education Press Science Textbook in this section can be roughly divided into: (1) a simple concept of quality; (2) Common units of quality and their conversion relationships; (3) Mass is an attribute of an object; (4) Common

instruments for quality measurement; (5) The usage method and experiment of tray balance;

In actual teaching, the knowledge of the above-mentioned sections has been divided. The first part is: (1) (2), with a teaching time of about 3 to 5 minutes. The second part is: (3), with a teaching time controlled within 5 minutes. As for the last part, which is (4) and (5), it is the key and difficult point of this lesson, and also a major teaching difficulty. The teaching time has correspondingly increased to 15 or even 20 minutes. In this part of the teaching, how to do a good demonstration experiment and achieve the corresponding teaching goals in the absence of experimental equipment resources is the key problem that this lesson needs to solve.

3. Learning goal setting

Learning objectives refer to the goals that teachers need to help students achieve in the teaching process. In addition to letting students know where they want to go, they also need to let them know whether they have arrived and how far they are to reach their ultimate destination.^[6] In order to implement the overall goal of cultivating students' scientific literacy in the science curriculum standards and meet the corresponding academic requirements^[7], this study decomposes the overall learning objectives of the course as follows:

3.1 Goal 1: Understand the simple concept and characteristics of quality

Sub objective 1: Students can demonstrate that an object is composed of matter, observe and compare the amount of matter contained in different objects.

Sub objective 2: Students can define "quality" in scientific language by combining real-life situations and findings.

Sub objective 3: Students are able to apply and convert different quality units based on actual needs.

Sub objective 4: Students can explain and give examples why "mass is an attribute of an object".

3.2 Goal 2: Understand commonly used quality measurement instruments and their usage methods

Sub objective 1: Students are able to independently read the textbook content, state common measuring instruments, their structures, and usage methods.

Sub objective 2: Students are able to summarize in their own language the process and precautions of using a tray balance to weigh solid and liquid masses through experimental observation and the PTA verification scale for the use of tray scales

3.3 Goal 3: Experimental results of analyzing the measurement of mass using a tray balance

Sub objective 1 can analyze the sources of measurement errors by combining the correct experimental steps and principles.

4. Analysis of Students' Learning Situation

Seventh grade junior high school students have already learned about the mass and units of objects in their past studies, and understand that mass is an attribute of objects. This lesson follows the arrangement of the teaching content and introduces the measuring instruments for measuring mass, especially the tray balance and its operating methods

In primary school, students have learned to have a preliminary understanding of the concepts of "light" and "heavy"; The tray balance is a more precise measuring instrument that students are using for the first time. Students are unfamiliar with the structure of the balance and have a vague understanding of the operating steps of the balance. However, first year students have rich imagination and active thinking, and are more willing to personally experiment and learn^[8]. Based on the above learning situation, the teacher guides students to understand the structure of each part of the scale and learn to use the scale in a standardized manner during the teaching process.^[9]

5. Teaching Reflection and Optimization

5.1 Adjusting class schedule

From the feedback from classmates, it can be seen that middle school students without knowledge reserves may not be able to understand this section well. Although the structure of the scale can be understood by combining pictures and equipment, the amount of information is relatively large and cannot be truly understood. It is necessary to spend time outside of class to strengthen memory. and we can ask one or two students to try to define it, and then Guide the students to further revise the definition, especially note The purpose is to distinguish between "weight" and "quality" to avoid confusion among students. Based on the student's learning situation, place the concept and characteristics of quality in the first lesson; And place the measuring instruments and usage methods in the second lesson, focusing on problem-solving for learning. Encouraging students to learn by doing and doing while learning can promote their understanding of knowledge and help them generate new questions. This kind of learning makes students more enthusiastic.^[10]

5.2 Adjusting teaching methods

Classroom teaching should be student-centered and guided by teachers, adhering to the existing experience and knowledge of students^[11]. Based on the students' existing experience with seesaws, design and improve the teaching of scale construction. Students are learning. During

the learning process, students constantly solve problems and constantly generate new ones, which invisibly enhances their scientific literacy. Despite investing a lot of time in student experiments during the teaching process, the effectiveness of this measure is far beyond the comparison of simple exercise exercises. Through hands-on experiments, students can not only proficiently master operational skills, but also deeply understand the scientific objectives and theoretical basis behind the experiments.

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