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Research on the Teaching Design of Problem Chain for Professional Ability Improvement

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Abstract: As a basic cultural course, mathematics course in vocational education should not only lay a good foundation for students, but also cooperate with professional courses, organically integrate professional spirit and form educational resultant force. The problem chain teaching based on the improvement of professional ability provides a field for cultivating outstanding professional quality, and the problem chain education with the goal problem as the main line provides an effective way to cultivate the core quality of mathematics. Adopting the cone volume model method to solve the problem of professional bartending is helpful to cultivate students' ability to solve practical problems and lay a good foundation for students' sustainable development.

1. The necessity of problem chain design for professional ability improvement

It is mentioned in the Mathematics Curriculum Standards for Secondary Vocational Schools (2020 Edition) that the task of mathematics curriculum is to help students acquire the necessary mathematical knowledge and skills, thinking methods and activity experience for further study and career development, so that students can have the ability to solve problems with mathematical methods and tools, and become high-quality skilled personnel with all-round development. Therefore, teachers should break the traditional teaching method, think about how to reconstruct the content of teaching materials, make mathematics lessons concrete and operable, close to students' career development, and improve students' enthusiasm for learning mathematics[1]. We should give full play to the professional characteristics and skills advantages of secondary vocational students, organically integrate the teaching of basic mathematics courses with professional skills learning, improve students' participation, let students know and do together. This paper takes the teaching of "the volume of cone" as an example to introduce the inquiry process of problem chain design directed to the improvement of professional ability.

2. The teaching mode of problem chain design for professional ability improvement

2.1. Analysis of teaching materials and learning situation

"The volume of a cone" is the content of the second lesson of the fourth section of the ninth chapter of "Mathematics Foundation Module Volume II" published by People's Education

Publishing House. Before this lesson, students have learned the concept of cylinder and calculation of volume. At the same time, it lays a foundation for the concept of sphere. This course is for students in modern business clusters, aiming to cultivate interdisciplinary talents. The students in the class are intuitive and good at hands-on operation; they have certain mathematical spatial imagination and abstract thinking ability; they not only love their major, but also take the course of hotel professional bartender.

2.2. Analysis of teaching objectives and difficulties

Students are always unable to master the quantity of various wines in the bartending course, so this lesson will help students to solve how to quantitatively customize three colour cocktails. Therefore, we will break down the problem into three steps. The first step: understanding the shape of the wine glass: conical wine glasses are often used in bartending classes. Students need to know the volume calculation of cone, and can use the height, generatrix and radius of the cone to calculate the volume, which is the goal of knowledge and skills; The second step: understanding the size of the wine glass. In order to let students fully understand the volume of wine poured into the wine glass, students personally verify the volume formula of the cone through experiments, and understand the basic method of learning mathematics, so that their intuitive perceptual knowledge of the model rises to the rational knowledge of the formula, that is, the process and method goal; The third step: calculating the amount of wine in each layer and customize the three-color cocktail quantitatively. Students use mathematical methods to solve practical problems in professional courses, which enhance their enthusiasm for learning mathematics and stimulates their interest in exploring, that is, emotional and attitudinal goals. From the above three steps, it is not difficult to see that if you want to make a cocktail, you must be able to calculate the volume of the wine in the glass. Therefore, the teaching focus of this lesson is to be able to calculate the volume of a cone by using the height, radius and any two of the generatrix of the cone. In practice, it is particularly difficult to calculate the volume of each layer when pouring three different kinds of wine. The volume calculation of large and small cones in the combination is the difficulty of this lesson.

2.3. Analysis of teaching and learning methods

Combining with the concept of professional cluster development of the school, I take the bartending problem as the main line, and complete the teaching process by raising problems, analyzing problems and solving a problem, which fully reflects the service and promotion of basic cultural courses to professional courses. Considering the knowledge level and understanding ability of students, with the help of micro-video, Geometer's Sketchpad, students are encouraged to explore problems, combine teaching with practice, and demonstrate intuitively, so as to make teaching more interesting and vivid[2]. Through learning, students successfully solve the problem of the volume of each wine in the three-color cocktail. After class, students use their knowledge to make a cocktail quantitatively and compare the volume of the three wines, which tastes better and costs less.

2.4. Design record of problem chain teaching process

2.4.1. Create professional situations and present target problems.

Target question: Watch the video of three colour cocktails, and find the target question: how to accurately calculate the dosage of three kinds of wine, so as to ensure good taste. Create problem situations with bartending videos, transform the teaching content into professional practice problems, so that students have a strong sense of problem, expect to solve the target problem, and

become professionals. This way can fully mobilize the enthusiasm of students

2.4.2. Driven by problem chain, analyzing problems layer by layer

Question 1 Explore the definition of the cone: In order to solve the target question raised by the bartending video. Students demonstrate the formation process of cone in kind, teachers demonstrate the formation process of cone in animation, and teachers and students sum up the concept of cone together. The geometric body enclosed by the curved surface formed by the rotation of the other two sides of a right-angled triangle with the straight line of one right-angled side as the rotation axis is called a cone. Introduce a formula in the cone: The height h, radius r and generatrix l of the cone form the formula $l^2 = h^2 + r^2$, so as to reserve knowledge for subsequent learning.

Question 3 Cone volume experiment $V = \frac{1}{3}\pi r^2 h$: conical container, let the students use the cone to hold the real object, pour it into the cylinder with the same bottom and height, and it is just full after pouring three times. Design intent: Students do experiments to demonstrate the volume formula, which fully reflects the teaching concept of learning by doing and learning by doing. Through the study of question 3, students have a preliminary understanding of the wine cup, paving the way for solving the target problem.

2.4.3. Creating a cone model and solving a layered task

Question 4 Knowledge application question: At the birthday party, two types of wine glasses, see in figure 1. The caliber of NO.1 wine glass is 10 cm and the depth is 6 cm, and the caliber of NO.2 wine glass is 8 cm and the depth is 8 cm. Which wine glass has a smaller capacity?

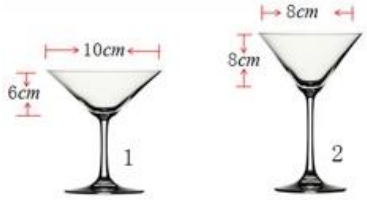

Figure 1: Two types of wine glasses

Solution: $\because d_1 = 10, h_1 = 6, r_1 = 5; = \frac{1}{3}\pi {r_1}^2 h_1 = \frac{1}{3}\pi \times 5^2 \times 6 = 50\pi cm^3; \because d_2 = 8, h_2 = 8,$ $r_2 = 4; \therefore V_2 = \frac{1}{3}\pi {r_2}^2 h_2 = \frac{1}{3}\pi \times 4^2 \times 8 = \frac{128}{3}\pi cm^3$. The second kind of glass has small capacity.

Design intent is to present exercises in the form of life stories, which can close the distance with students, enhance the attractiveness of the classroom, and teach students how to calculate the capacity of different wine glasses. In order to facilitate students to solve the problem smoothly, we once again decompose the target problem to reduce the difficulty, that is, to learn to start with the problem of single-layer wine.

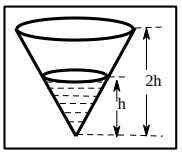

Figure 2: Half of the wine in the glass

Question 5 Professional Situation Question: Play the video of the bar owner making the world's most expensive cocktail to enliven the classroom atmosphere and improve students' attention. When the owner wants to take a break at half the height of pouring, do you know how much he poured. As shown in the figure 2, the conical container contains 3 liters of water, and the height of the water

surface is exactly half of the height of the cone. How much water can this container hold?

$$Solution: \because V_{small} = \frac{1}{3}\pi r^2 h = 3; V_{big} = \frac{1}{3}\pi(2r)^2(2h) = 8 \times \frac{1}{3}\pi r^2 h = 24;$$
$$\therefore V_{big} - V_{small} = 21.$$

Design intent: Students recognize the cone in the combination and try to explore the solution, which is explained by the teacher and demonstrated on the blackboard. Question 5 transforms the volume of an unfamiliar figure into the volume of a familiar figure, highlighting the idea of transformation in mathematics. It paves the way for solving the problem of calculating the weight of each wine in the three-color cocktail.

2.4.4. Professional ability sublimation, casting the heart of craftsmen

Question 6 Pre-class goal question: Given that the height of three different colors of wine is 3 cm, and the diameter of the top red wine level is 12 cm, as shown in figure 3, how many milliliters are the volume of the three wines?

Figure 3: Three color cocktail

Solution: $\boldsymbol{h_3 = 3 \times 3 = 9, h_2 = 3 \times 2 = 6, h_1 = 3;\ h_3 : h_2 : h_1 = 3:2:1; r_3 = 6, r_2 = 4, r_1 = 2; V_3 = \frac{1}{3}\pi {r_3}^2 h_3 = 108\pi; V_2 = \frac{1}{3}\pi {r_2}^2 h_2 = 32\pi; V_1 = \frac{1}{3}\pi {r_1}^2 h_1 = 4\pi;\ V_{yellow} = 4\pi \approx 12.56\ milliliter;\ V_{green} = 32\pi - 4\pi \approx 87.92\ milliliter;\ V_{red} = 108\pi - 32\pi = 76\pi \approx 238.64\ milliliter.}$

Design intent is to solve the problem and complete the task with the idea of spatializing the plane. Using the cone model to solve the calculation problem of three layers of wine, decomposing a practical application problem one by one, so that students can successfully solve the target problem raised before class.

3. Exploration practice and reflection of problem chain teaching design

3.1. Create professional situations to stimulate learning desire

The initial goal of the problem chain is particularly critical, which can often better stimulate students' desire to learn. When choosing the target problem, we can combine the professional characteristics of secondary vocational students and the problems that students often encounter in their study and life. For example, in this lesson, how to make three colour cocktails without waste? Many students want to find a way to know the dosage of three kinds of wine in advance. Teachers guide students to use mathematical methods to solve problems that bother them. Therefore, they must be proactive in learning.

3.2. Focus on knowledge review, and decompose problems layer by layer

Secondary vocational school students often lack motivation to learn, and the knowledge they have mastered in the early stage is easy to forget, which is needed in class. Therefore, we should pay attention to helping students review the knowledge of the last lesson. In the setting of the problem chain, we should pay attention to examining the specific knowledge and ability points, so as to make full preparations for solving the target problems step by step. Secondary vocational

school students are generally weak in mathematics and difficult to deal with complex problems. Only one method is examined when designing problems. Clear training objectives enable students to achieve accurate analogical learning, draw inferences from one instance, and comprehensively solve complex problems.

3.3. Strengthen the heart of craftsmen and implement moral education

Accurate mathematical calculation ability helps students form the spirit of craftsmen in the new era of excellence, which is also the embodiment of the fundamental task of cultivating people by virtue. The problem chain should be designed from the beginning to the end, always around the professional skills, so that students can solve problems in the inquiry experience, improve their mathematical knowledge ability and professional skills, easier to be acquired by students[3]. In the teaching of this lesson, students can quickly and accurately master the dosage of three colour cocktails through mathematical methods, which make them more accurate in the process of preparation, thus cultivating one of the important qualities of craftsmen.

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