# Experimental Research on Mathematical Communication in Mathematics Teaching of Secondary Vocational Schools

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**Abstract:** Mathematical communication is not only a way of learning mathematics, but also a means of teaching mathematics. In order to test whether the mathematical communication activities carried out by secondary vocational schools can improve the difficulties of mathematical teaching in secondary vocational schools, the author has carried out a one-year experimental research by using relevant teaching strategies of mathematical communication. The author gives teaching cases of mathematical communication in mathematics class of secondary vocational schools, and verifies the value of mathematical communication in mathematical teaching of secondary vocational schools from four aspects of examination results, questionnaire survey, interview and case study.

**Keywords:** Secondary vocational mathematics; Mathematical communication; Experimental case; Effect analysis

## 1. Introduction

With the development of mathematical teaching reform at home and abroad, mathematical communication has obtained more and more attention from mathematical educators. In the process of mathematical communication between teachers and students, students and students, students can use mathematical language to express their mathematical thoughts and emotions consciously and purposefully. At the same time, they can also learn to analyze problems from different angles and solve problems with different methods from others, which plays a very important role in the in-depth study of mathematical knowledge. Considering the current situation of mathematical teaching in secondary vocational schools, the author has carried out a one-year experimental study with relevant mathematical communication strategies based on the characteristics of students in secondary vocational schools who have poor math foundation but are active.

## 2. Experimental Design

### 2.1 Experimental Purposes

The purpose of this experiment is to change the traditional teaching concept of mathematics in secondary vocational schools, introduce the teaching concepts of mathematical communication, and implement the teaching strategies of mathematical communication. Thus, it finally tests that whether the secondary vocational schools that carry out mathematical exchange activities can improve the dilemma of secondary vocational mathematical teaching:

(1) Whether mathematical communication is helpful to improve students' mathematics scores;

(2) Whether mathematical communication can change students' attitude and interest in learning mathematics;

### 2.2 Experimental Objects and Time

Experimental object: Class 1 and class 2 of the four "3+ certificates" college entrance examination classes of a secondary vocational school in Dongguan in 2019. Class 1 is selected as the experimental class with 34 students, while class 2 is selected as the control class with 35 students.

Experimental time: March 2018 to January 2019

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### 2.3 Experimental Description

(1) The author assumes mathematics teaching for both experimental class and control class. In the classroom practice teaching, the control class carries out the traditional teaching mode, and the experimental class carries out mathematical communication activities and implements mathematical communication strategies.

(2) The strategies for mathematical communication mainly include: ① Renewing the concept of mathematical teaching and enhancing the awareness of mathematical communication; ② Creating mathematical communication situation, and stimulate the desire of students to communicate; ③ Cultivating students' problem consciousness and enhancing the depth of mathematical communication; ④ Strengthening the mathematical language training, and improving the efficiency of mathematical communication; ⑤ Advocating students' mathematical writing and enhancing students' mathematical thinking; ⑥ Evaluating mathematical communication reasonably and promoting its implementation.

(3) Experimental class and control class use the same teaching materials, their teaching content and teaching progress are synchronized. Both classes are assigned the same homework and exercises to make sure they spend about the same amount of time studying math.

(4) Pretest: Before the experiment (March 2018), as for the scores of the entrance examinations of the higher vocational college entrance examinations, the difference between the two classes was very small, which has little effect on the experimental results.

(5) Post-test: At the end of the experiment (January 2019), the questionnaire survey of the experimental class and the college entrance examination results of the experimental class and the control class in Guangdong Province in 2009.

### 2.4 Analysis of Experimental Variables

Independent variable: X= mathematical communication activities in classroom teaching

Dependent variable and measurement: Y1= students' post-test results (college entrance examination results of higher vocational colleges)

Y2= students' attitude and interest in mathematical learning (questionnaire and interview)

## 3. Experimental Cases

Topic: The Concept of Function

Original intention of design: Creating situations of mathematical communication and strengthening the training of mathematical language are important strategies to promote mathematical communication. The concept of function is abstract and difficult for students to understand. Thus, in order to help students learn the concept of function more deeply, it is necessary to create a situation of mathematical communication from practical problems, and at the same time, to deeply analyze the words and symbols in the concept of function.

Teaching segment 1

Teacher: We have learned function in junior high school, please judge: ① Does "$y=1$" represent a function? ② Does $y=x$ and $y=\frac{x^2}{x}$ represent the same function?

The classroom suddenly becomes very quiet and the students are in deep thought.

Student 1: I don't think "$y=1$" is a function because I can't see the independent variable $x$ in the analytic expression.

Student 2: The numerator and denominator of function $y=\frac{x^2}{x}$ can be divided out $x$ to become $y=x$, so functions $y=\frac{x^2}{x}$ and $y=x$ represent the same function.

Teacher: Although we have learned the concept of function in junior high school and know that function can be used to describe the dependency between two variables, it is difficult to answer the above questions according to its definition of junior high school function. Thus, we continue to learn the function and its constituent elements today, and hope that the students can correctly answer the above questions through the study of this lesson.

Teaching segment 2

Teacher: Firstly, let's look at three examples:

Example 1: The school store sells a certain kind of juice drink at a price of 2.5 yuan per bottle. What is the relationship between the number of bottles $x$ (bottle) and the dues $y$ (yuan) for buying juice drinks?

Example 2: Since China participated in the Olympic Games in 1984, the number of gold medals obtained in each session and the corresponding year are shown in Table 1 below. Please indicate the correspondence between the year $x$ and the corresponding number of gold medals $y$ .

Table 1 The Number of Gold Medals Won in Each Olympic Games in China

| Year ( $x$ ) | 1984 | 1988 | 1992 | 1996 | 2000 | 2004 | 2008 | 2012 | 2016 |
|---|---|---|---|---|---|---|---|---|---|
| Number of Gold Medals ( $y$ ) | 15 | 5 | 16 | 16 | 28 | 32 | 51 | 38 | 26 |

Teacher: Combining the function concept learned in junior high school, please point out the relationship between the number of bottles $x$ (bottles) and the dues $y$ (yuan) for purchasing fruit juice drinks.

Student 3: $y = 2.5x$

Student 4: But the bottle number $x$ must be the natural number, that is $x \in N$ .

Teacher: Well down! Next, please think about the relationship between the variables in Example 2. Can you write the concrete relationship between the two variables like in Example 1?

The students begin to hesitate, and some students are about to speak, but saying nothing.

Student 5: No, because there is no rule between variables in example 2.

Teacher: Right, then the correspondence of the variables in these two examples is the same?

Student 6: It's obviously different.

Teacher: What are the common characteristics of the correspondence among variables in the two examples?

Student 7: In Example 1 and 2, when $x$ takes any value, $y$ has a unique value corresponding to it.

Teaching segment 3

Teacher: Find out the key words you think are important in the function definition and explain the reasons.

Students reread the concept of functions in the textbook, and some of them keep drawing lines in the textbook. Team members discuss and exchange ideas, and send representatives on the platform to report the exchange results.

Group representative 1: I think the word "unique" is very important, because each independent variable can only get a unique $y$ value.

Teacher: Can you give an example of an independent variable whose $y$ value is not unique?

Group representative 1: $y = \pm x$ . (Not yet waiting for the teacher to speak)

Group representative 2: When $x = 0$ , isn't $y$ a unique?

Group representative 1: Oh, yes, the word "any" is also important.

Teacher: Everyone is very good! The role of "any" and "unique" in the concept of the function is very important, and are the key words to test whether two variables can form a functional relationship. However, students should also pay attention to the independent variable has a certain range of values (number set D).

## 4. Analysis of Experimental Effect

### 4.1 Analysis of the Examination Scores of the Experimental Class and the Controlled Class.

Our school has conducted a unified entrance examination for the third-year students of secondary vocational schools who are going to take part in the college entrance examination in 2019. Their proposition content and question type are similar to the college entrance examination of higher vocational colleges in previous years. The examination time and scoring are also the unified arrangement of the school's educational administration department, and the results of this examination are pre-test data of the experimental and control classes. The post-test data of the two classes is the scores of the Guangdong higher vocational college entrance examination in January 2019, which should be very objective, fair and representative.

Table 2 Statistical Table of Pretest and Post-test Data (Scores) of Experimental Class and Control Class

| Class/Score | Above 120 | 100-120 | 80-100 | 60-80 | Below 60 | Average | Passing rate |
|---|---|---|---|---|---|---|---|
| Pretest of experimental class | 0 | 0 | 2 | 4 | 28 | 41.4 | 2.9% |
| Pretest of control class | 0 | 1 | 3 | 2 | 29 | 41.8 | 5.7% |
| Post-test of experimental class | 6 | 6 | 3 | 4 | 15 | 74.3 | 38.2% |
| Post-test of control class | 4 | 2 | 3 | 5 | 21 | 60.1 | 22.9% |

As can be seen from the experimental data in table 2, the difference between the pretest data of the two classes is very small, but after the experimental class carries out mathematical communication, the students' performance improves significantly. Both the pass rate and the average score of the experimental class are improved more than that of the control class. Among them, the passing rate of the experimental class is 15.3% higher than that of the control class, and the average score is 14.2 points higher than the control class. In traditional teaching, secondary vocational students often have insufficient concentration and are easy to distract. They are unable to answer questions raised by teachers, and few students actively answer questions. However, in the process of mathematical communication in the experimental class, this situation has been greatly improved. Most students can focus on learning and actively answer questions from teachers. This shows that conducting mathematical communication can change the learning style of traditional teaching. Students can actively participate in classroom teaching, actively think about teachers' questions, discuss with other students, cooperate and explore, and truly experience the fun of learning mathematics. Learning mathematics has changed from passive acceptance to active exploration, which not only improves mathematical scores, but also effectively improves the dilemma of mathematical teaching in secondary vocational schools.

### 4.2 Analysis of Questionnaire in Experimental Class

In order to understand the effect of mathematical communication in secondary vocational schools, a questionnaire survey is conducted among all students in the experimental class. According to the statistical data of the questionnaire, it can be found that:

(1) Mathematical communication has changed students' attitude towards learning mathematics. From Fig. 1, we can see that 97% of the students have improved their enthusiasm in mathematical learning compared with the previous, and 26% of them have improved their enthusiasm very obviously.

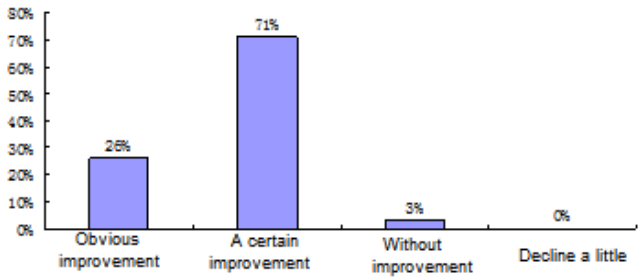


Fig. 1 Students' Enthusiasm for Learning Mathematics after Experiment

(2) Mathematical communication has improved students' interest in learning mathematics. As can be seen from Figure 2, 68% of students have begun to like to learn mathematics, and 33% of them like mathematics very much.

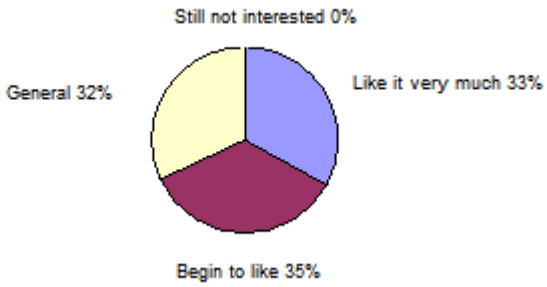


Fig.2 Students' Interest in Learning Mathematics after Experiment

It can be seen that after the implementation of mathematical communication in secondary vocational mathematical teaching, students' interest in mathematics is stimulated, which changes their understanding of mathematics to some extent. By participating in mathematical communication activities, students' enthusiasm in learning mathematics is improved. They are willing to communicate with others and the frequency of mathematical communication is greatly improved. In addition, the atmosphere of learning mathematics is getting stronger and stronger, which has effectively improved the dilemma of mathematical teaching in secondary vocational schools.

### 4.3 Analysis of Interview in Experimental Class

In order to understand the actual situation of students more clearly, the author has selected a student from the upper, middle and lower levels of the experimental class for an interview. From the answers of students at different levels, it can be found that most of the students are very satisfied with conducting mathematical communication activities in secondary vocational mathematical teaching, and have basically adapted to mathematical communication teaching, and think it is very necessary to promote this teaching method. First of all, in the creation of mathematical communication situation, mathematical knowledge is combined with professional knowledge and practical problems, so that students can truly feel the value of mathematics, and to a great degree, stimulate the motivation of students to learn mathematics; Secondly, mathematical communication reflects the dominant position of students. Each student has the opportunity to express their understanding of relevant mathematical problems and complete the analysis and discussion of mathematical problems in a relaxing and pleasant atmosphere, so that students can feel the fun of mathematics. Finally, with the development of mathematical communication activities, students at different levels have improved their scores to different degrees, their confidence in learning mathematics has been enhanced, and their interest in learning mathematics has been improved.

### 4.4 Analysis of Case Study

In order to understand the effect of mathematical communication on mathematical learning of students at different levels, the author has made a follow-up research on one student from three different levels of mathematics in the experimental class. Through the experiment and observation of nearly one year, the three students' math scores and attitudes towards learning mathematics have changed to different degrees. The following is the relevant information of the three students:

(1) Student Zhao, male, a good performance in mathematics, 95 entrance score, interested in mathematics, but not good at language expression. At the beginning of the experiment, the author has focused on the mathematical language training of the student; In the middle of the experiment, with the enhancement of the student's language expression ability and his interest in mathematics, the author has introduced some practical problems for him to think about and expand his vision of mathematics; At the end of the experiment, the student was required to write a small paper on mathematics with his good foundation. Through these measures and means, the student's

mathematical scores have made rapid progress. Table 3 shows the results of Zhao's monthly exam and college entrance examination.

Table 3 The Scores of 9 Mathematical Examinations of Zhao

| Times | 1st | 2nd | 3rd | 4th | 5th | 6th | 7th | 8th | College entrance examination |
|---|---|---|---|---|---|---|---|---|---|
| Scores | 95 | 127 | 105 | 116 | 92 | 129 | 122 | 131 | 149 |

(2)Student Chen, female, with moderate mathematical scores and 65 entrance scores, very open-minded, a strong ability of language expression, but careless in problem-solving. At the beginning, according to the characteristics of the student, the author has arranged her to be the head of the mathematical group, and equipped her students with better math scores as her team members, to motivate her to learn math and change her careless habits; In the middle stage, as she has a certain foundation of mathematics, she is cultivated with her problem awareness and enhanced the depth of mathematical communication with others; Later, the author has focused on training her mathematical thinking, to overcome some difficult mathematical problems.

Table 4 The Scores of 9 Mathematical Examinations of Chen

| Times | 1st | 2nd | 3rd | 4th | 5th | 6th | 7th | 8th | College entrance examination |
|---|---|---|---|---|---|---|---|---|---|
| Scores | 65 | 76 | 54 | 70 | 66 | 81 | 90 | 87 | 121 |

(3)Student Wang, male, a poor foundation in mathematics, 42 admission score, poor learning habits, no interest in mathematics, and easy to sleep or wander in class. In the experiment, the author has often talked with him to change his attitude towards mathematics and asked him to write a mathematical diary. After writing out his inner understanding of mathematics and problem-solving psychology, the author has provided timely guidance and encouraged him to try to communicate with classmates at the same level. In the end, the student's learning attitude has been changed, and his academic performance has made some progress.

Table 5 The Scores of 9 Mathematical Examinations of Wang

| Times | 1st | 2nd | 3rd | 4th | 5th | 6th | 7th | 8th | College entrance examination |
|---|---|---|---|---|---|---|---|---|---|
| Scores | 42 | 45 | 25 | 30 | 41 | 50 | 62 | 55 | 84 |

To sum up, on the one hand, conducting mathematical communication activities in mathematical teaching in secondary vocational schools can improve the mathematics scores of secondary vocational students. On the other hand, it can also change the attitude and interest of secondary vocational students in learning mathematics, which plays a very important role in improving the dilemma of secondary vocational mathematical teaching.

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