

Research on the Micro-course Design of Situational Inquiry Teaching of Middle School Mathematics

Taking the Difference of Two Squares as an Example*

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Abstract—With the rapid development of information technology, the teaching forms of middle school mathematics are also diversified, and the application of micro-course provides a new way for mathematics teaching. Taking the mathematics course as an example, this paper makes an in-depth study of the micro-course of inquiry in middle school mathematics from the following aspects: the creation of the situation of inquiry micro-course, the proposal of teaching problems, the design of teaching process, the selection of teaching tools, the production of teaching resources, and the use of micro-course production software. It summarizes the design methods and procedures of inquiry micro-course in middle school mathematics, and provides reference for the teaching of middle school mathematics.

Keywords—middle school mathematics; inquiry teaching method; the difference of two squares

I. INTRODUCTION

With the development of information technology, micro-course has gradually become one of the main ways for students to learn, and has been widely used in pre-class preparation [1], in-class learning, after-class review and other teaching and learning links. Many students also take micro-course as one of the main resources for independent learning [2]. Vibrant personality and active thinking, middle school students already have the ability of exploring familiar problems cooperatively and abstract summarizing, and they can solve some of the mathematical problems with the thought of symbolic-graphic combination. Therefore, inquiry teaching method, as a common teaching method in mathematics teaching, is widely used by teachers. Also, as a new teaching mode, inquiry-based teaching conforms to the teaching concept of "autonomy, cooperation and inquiry". It centers on the development of students and enables them to learn effectively and acquire the ability of self-development by carrying out inquiry-based teaching [3]. The application of inquiry-based micro-course to mathematics teaching in junior high school can promote students' interest in learning

and improve classroom teaching effect.

However, inquiry-based micro-course in China is still in its initial stage. The practical application of micro-course teaching is not yet mature, and micro-course is more a tool for teachers to communicate with each other [4]. In practical application, there are many problems with micro-course. Teachers do not pay enough attention to the design of "micro-course" content [5], and the sources of micro-course have a single form of expression and are not attractive enough to attract students to study for a long time. The teaching methods used by teachers are too traditional, resulting in very low teaching quality [6]. How to make the micro-course of mathematical inquiry in middle school better so as to improve the learning effect of students and the teaching level of teachers is a hot topic of many scholars.

II. INQUIRY TEACHING THEORY

The use of inquiry in teaching was first proposed by Dewey. In his opinion, education is not only to let students learn a lot of knowledge, but more importantly to let them learn the process or method of scientific research.

Inquiry teaching method is also known as the discovery method and research method. It is an method in which when students learn new concepts and principles of knowledge, the teacher gives them some examples, creates the knowledge inquiry situation, then throws the question, and lets them explore actively, discovers and grasps the corresponding knowledge principle through the ways of reading, the observation, the experiment, thought, the discussion, listens to the lecture and so on. In this method, students who are the subject, under the guidance of teachers, are required to actively explore, master the methods and steps to solve problems, study the attributes of objective things, and find the internal relations between things, so as to find out the rules, and establish their own cognitive model and learning methods.

The situational "inquiry teaching method" is used to make teaching resources, mainly the production of micro-courses teaching. In the design and production process of micro-course teaching, knowledge points and learners should be analyzed firstly. Immersive situations that are easy to

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understand are set up according to the characteristics of knowledge points and the learners, to lead to learners' desire for inquiry. Then students are guided to solve the problems they are facing, with consideration of their existing relevant knowledge and experience so as to complete the knowledge learning.

III. THE PRODUCTION OF MICRO-COURSE CASES

Taking the knowledge point of "the difference of two squares" as an example, this paper designs the inquiry micro-course.

A. The Analysis of Learning Actuality

1) *Analysis of knowledge points in middle school mathematics*: "The difference of two squares" belongs to the "number and algebra" part of the "mathematics curriculum standard" in the nine-year obligation education period. (2011 edition). Students have learned polynomial multiplication before and can use the multiplication formula to perform simple operations on polynomial multiplication. As a further supplement to the multiplication formula, the difference of two squares provides the simple arithmetic of special polynomial multiplication. It lays a foundation for future factorization, simplification of fraction and solving unitary quadratic equation, and also paves the way for the study of complete square formula. The multiplication formula is a representation of the multiplication of two special polynomials, and the "the difference of two squares" is the natural transition to polynomial multiplication with special form on the basis of learning integral multiplication, which conforms to the rule from general to special, and is also the expansion and deepening of the multiplication formula. The difference of two squares is the first formula in middle school, one of the most widely used formulas in algebra and even in the whole mathematics. It is an important carrier of students' algebraic knowledge and plays a connecting role in the textbook.

2) *The analysis of learners*: In the previous class, students learned how to decompose factors by factoring out common factors. They initially realized the inverse relationship between factor decomposition and multiplication operations. Thus, the natural transition to multiplication with special form of polynomials conforms to the cognitive law from general to special, and it is also a good opportunity to stimulate students' thirst for knowledge. At this stage, students have the ability of independent inquiry learning, but their abilities of observation, induction, analogy and generalization need to be improved. Based on the characteristics of the knowledge points and characters of students at this stage, the teaching concept focus on learning should be followed and the teaching method of inquiring and experiencing should be given the priority, to create a good learning situation for students. In this way can the students can deepen their understanding of the formula through their independently inquiry. At the same time,

considering the individual differences of students, hierarchical teaching is adopted in each link.

3) *Teaching objectives*: By creating the problem situation, students can establish the model of the difference of two squares and get familiar with it in mathematical activities. Through the process of exploring the difference of two squares, they can tell its structural characteristics, deduce and verify it, learn to use it for simple operations, and feel the significance and function of mathematical formulas. In the process of solving practical problems by using formulas, students' symbolic sense, logical thinking ability, generalization thinking, reverse thinking and the ability to express reasoning are cultivated.

Through cooperative inquiry, students are trained to be exploratory and creative, and obtain successful experience in the learning process, so that their desire for inquiry and knowledge can be stimulated. Therefore students can feel that mathematics is not only from the reality of life, but also a tool to solve many problems in life, and such learning is valuable, so that they will be encouraged to love mathematics and study it.

B. Script Design of the Inquiry-based Teaching of "the Difference of Two Squares"

Generally, a problem consists of three basic components: known conditions, goals and solutions [7]. Before they learned the difference of two squares, students learned how to multiply polynomials. Therefore, in order to achieve the teaching goal of this formula, it is necessary to make use of the existing knowledge. In the introduction part of the teaching design, the competition video of "The Brain" is designed as the introduction of teaching design to present the super memory of the contestants for the students, which further indicates that the contestants use formulas to memorize, thus emphasizing the importance of the formula and leading to the knowledge point of this section — the difference of two squares. With the help of the existing knowledge, assuming that the formula of the square variance is generally valid, the algebraic method and the geometric method are respectively verified. Among them, the geometric method uses origami to make object demonstration and geometer sketchpad to conduct dynamic demonstration to complete the learning of the formula of the square variance. The problems in teaching resources and the design of exercises after class will be proposed based on the creation of the situation, and the use of formulas to solve practical problems in life. The teaching script design of "the difference of two squares" is shown in "Table I":

TABLE I. TEACHING SCRIPT DESIGN OF THE DIFFERENCE OF TWO SQUARES

Teaching link	Teaching content	Scenes	Design intent
Lead-in	Recently, "The Brain" broadcast by Jiangsu TV gets very popular and the super quick calculation ability of the contestants in the program is really enviable. Now let's feel the warm scene of the competition!	The teacher come up on the scene.	Introduction of knowledge points
Situation creation	In the videos of the competition, contestants calculate the results in a short time.	Videos of the competition in "The Brain" is playing.	Stimulate students' thirst for knowledge and exploration, and point out the importance of formulas through playing the wonderful video of the contestants.
Leads to the topic	How did they calculate the result in such a short time? Do they really have super computing power? In fact, a lot of complicated computations are tricky, they all have a password. If we master these passwords, we too can become super brains. Let's explore a commonly used cryptographic formula in calculation — the difference of two squares.	The teacher shows up.	Take the students from video to the difference of two squares.
Review existing knowledge	Look at the following two sets of equations and think about what is the rule on both sides of the equation? $(x+3)(x-3)=x^2+3x-3x-9=x^2-3^2$ $(5+n)(5-n)=25+5n-5n-n^2=5^2-n^2$	Interactive question-and-answer between teachers and students by use of the PPT.	Ask questions directly, arouse students' existing knowledge, so as to lead students to the zone of proximal development of thinking in this class, and lay a foundation for new class learning.
The existing knowledge is processed and refined	The left-hand side of this equation is the sum of the two numbers times the difference between the two numbers. And in the right-hand side of this equation, pay attention, are still the two numbers, which just have a hat on the top of each and then subtract. So let's guess, is this true for all polynomials multiplication like this?	The teacher's explanation.	Starting from the polynomial multiplication that students are familiar with, encourage students to actively explore, guess boldly to mobilize their enthusiasm Let students feel the process of mathematical re-creation, turn the special into the general, cultivate the thought of mathematical modeling and transformation At the same time they can feel the interconnection of knowledge and improve the ability to extract knowledge. The square is designed as the vivid image of "hat" and this helps students easily remember the deformed expression and deepen the memory.
Performance demonstration	Since this is the multiplication of two polynomials, polynomial multiplication rule can be used to expand it and unite similar terms to get the result. Just like the algebraic form above, the algebraic test holds, does the geometric method hold?	Hands-on demonstration operation on electronic whiteboard.	Computing with the help of the polynomial multiplication formula rule on the electronic whiteboard make students clearly feel the whole process of computing, which makes it easier for them to understand and accept the knowledge.
Visual demonstration	So I have a big square with side length a , and if I am going to explain this in geometric terms I can cut out a little rectangle with side length b from the big square, then the area left over would be the result, so how do I construct it? We cut the rest of the graph along this line using the cut-supplement method and it becomes two rectangles. So the length of the bigger rectangle is a and the width is $a-b$, and the length of the smaller $a-b$ and the width is b . We can find that the length of a small rectangle is equal to the width of the large one, so we can recombine these two shapes into a rectangle whose length is $a+b$ and width $a-b$. With close attention can we find that from two changes, only the shape of the graph has changed and the area of the graph has not changed, which once again proves the correctness of the difference of two squares. The size of b is fixed in the demo. If we change the size of b , will we get the same result?	The teacher uses origami to demonstrate the geometric verification.	Step by step, learn from shallow to deep contents. Guide students to understand the formula of square difference to broaden students' thinking and improve their operational ability. Infiltrate the thought of symbolic-graphic combination and make them understand symbolic-graphic combination the geometric background of the formula. Also, teach students to look at problems and solve problems from multiple perspectives.

Teaching link	Teaching content	Scenes	Design intent
Dynamic demonstration	Now let's use the geometer sketchpad to construct this process, and if we change the size of b during the demo, we can see that the sum stays the same.	The geometric sketchpad dynamically demonstrates the deformation process of the difference of two squares.	Once again, students can feel the application of geometric intuition in mathematics and they can realize the status and role of the combination of number and shape in mathematics.
Overview of the concepts	If you generalize in one sentence that the product of the sum of two numbers and the difference between these two numbers, is equal to the variance of the squares of these two numbers, that's the famous formula of the difference of two squares.	PPT presentation plus whiteboard blackboard presentation.	The difference of two squares that we want to master in this lesson is verified through the previous conjecture.
Summary	From the above process, we used different methods to prove the correctness of the difference of two squares, and learned to analyze the problem from multiple perspectives. So you can have a super brain too if you think actively, make innovations boldly and keep finding and accumulating these formulas in learning.	The teacher shows up.	Make a summary to cultivate students' inquiry-based thinking, the habit of seek solutions to problems from different angles, pride in learning and active learning attitude.

C. Production of Inquiry Micro-course About "the Difference of Two Squares"

1) *Live video shooting*: The live video shooting consists of three parts: the teacher coming up, explanation through whiteboard writing and visual demonstration. The blue screen is used to shoot the opening part of the film, which is convenient for later matting. The whiteboard writing sections were shot during the phrase with sufficient light in the classroom. The parts of visual demonstration and the formula deformation solution were completed by digital camera. Place the digital camera on top of the white paper and adjust it to the camera function, with the auxiliary lighting and reflective hood and so on surrounded for shooting.

2) *Sound production*: In order to avoid inconsistent sound in micro-course, the recording of sound needs to be completed at one time. Firstly, CoolEdit software is used to record a section of sound under quiet indoor conditions as a sample of noise elimination. Then record the explanation sound in each picture according to the steps in the teaching design, and number and name according to the teaching order. After recording, noise reduction is carried out, and unnecessary parts are cut out. Leave a blank space before and after the sound for subsequent editing. And save the edited sound file by number finally.

3) *Course ware video production*: PowerPoint is used to produce the video of the course-ware. First open the previously recorded sound, then open the screen recording software super recording screen 8.0 for screen recording. The super record screen 8.0 is set as no sound recording, no mouse recording and the course-ware are set as full-screen play. Operate the playback speed of the course-ware according to the recorded explanation sound rhythm, so that the explanation sound and the playback of the courseware can be synchronized. After recording, the course-ware video

without sound recorded will be named according to the serial number name of the sound file, and the course-ware video will be generated.

4) *The image matting of the teachers showing up*: The Adobe Ultra CS3 software is used for image matting. Import the video which needs to be matted into Adobe Ultra CS3, and use the matting menu. Select a number of blue pixels evenly for the part to be removed, and then set the parameters of image matting to conduct image matting. Set the appropriate virtual scene for video through the virtual scene menu, and then save the video.

5) *Video editing*: Adobe Premiere pro CC is used for the final micro-course synthesis. First, import the prefixes into Adobe Premiere pro CC. Next, import each part of teaching video according to the named serial number and import the sound file according to the corresponding serial number in the sound track. Cut out the redundant picture and sound, set the appropriate transition effect by switching between the pictures, and present the conclusion in the way of picture in picture. The large picture is the teacher's summary, and the small picture is the formula deformation demonstration. Add background music in the required part, adjust video and sound parameters, make the tone and sound of the whole file consistent, and then generate video file. The final teaching time of video is about 8 minutes.

IV. THE APPLICATION OF MICRO-COURSE

Apply the produced video to teaching practice in the following three modes: the teacher teaches; play teaching video repeatedly; play teaching video plus the teacher teaches. Five classes were selected as experimental objects in a middle school. The test results are shown in "Table II":

TABLE II. TEST RESULTS

Modes	Class	Average scores
The teacher teaches	1	75.1
The teacher teaches	5	73.9
play teaching video for multiple times	2	75.3
play teaching video plus the teacher teaches	4	81.2
play teaching video plus the teacher teaches	3	85

As can be seen from the different learning effects of students in class 1, class 5 and class 2, the learning effect of students is improved but the improvement is not obvious when the video teaching is played repeatedly and the knowledge points taught by teachers are compared. By comparing class 1, class 2 and class 5 with class 4 and class 3, it is found that students perform well in the video + teacher teaching mode, and they master the knowledge well.

The majority of students said that micro courses can attract students' attention in a short time, and the content explanation is more intuitive and understandable than the teacher's teaching, which is impressive. However, when the video is too long it lacks interest. Students' attention span is too short to focus for a long time. Since students have short attention spans, they are unable to focus for long periods of time. The inquiry-based situation designed according to the characteristics of knowledge points directly affects students' attention in class, and in the micro-course design, the visual demonstration and geometric demonstration on sketchpad have good effect. So students can deepen their understanding for knowledge points and accelerate learning progress. The combination of playing micro-course video with teacher's teaching can ensure students' concentration and absorption of knowledge. Students also give some suggestion. For example, they suggest that students watch the video for preparing lessons before class, the situation created be closer to knowledge points, the exercises set be closely related to the situation and the micro-courses be applied to after-school review.

V. CONCLUSION

The general process of situational inquiry micro-course design is as follows: Choose knowledge points that are suitable for inquiry-based teaching methods; analyze the characteristics of the knowledge points and the learners; create inquiry-based situations that are close to the knowledge points and can provoke students' desire to explore, based on the analysis of the characteristics of the knowledge points and the learners; then propose the problem to be solved; next review the relevant knowledge points learned and use the existing knowledge to explore and master new knowledge. The teaching script of micro-course is designed according to each teaching step. In order to ensure the effect of micro-course, sound and video materials should be prepared separately. Prepare sound and video material according to the order of teaching script design, and name all kinds of materials according to the order of teaching script. Finally use the Premiere software to integrate materials and complete the production of micro-course teaching.

The micro-courses designed by inquiry teaching method produce many learning resources that can be used by students for independent learning by the application of various softwares and thus can be applied to preview before class, study in class and review after class. When designing the micro-courses, the design of situations must be attractive. Making the micro-courses more interesting, with combination of teacher's teaching, can greatly promote students' learning effect.

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