Practical Research on the Integration of Modern Information Technology and Mathematics Teaching Course in Chinese Senior High Schools - Taking Exponential Function as an Example

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Abstract – **The integration of modern information technology and high school mathematics curriculum has become an inevitable trend in the development of high school mathematics curriculum. The advantage of applying information technology to high school mathematics teaching is that it opens the door of students' thinking and provides more abundant content for classroom teaching. Modern educational technology presents words and graphical sounds in front of students, which can transform knowledge into a form that students like more truly and vividly. Using modern educational technology to assist teaching can speed up students' learning efficiency, make students better memory, mobilize students' senses comprehensively and devote themselves to learning. It can not only attract students' attention, but also create a good learning atmosphere and situation, so that students can have a good empathy to the teaching content. Visualized memory of classroom content, stimulate association to speed up the process of memory. After the analysis of teaching materials and learning conditions, this paper takes the teaching of exponential function image and its nature as an example, combines the mathematical software - Super Sketchpad with the teaching of exponential function, and carries out teaching practice and research.**

Keywords – **Modern Information Technology, High School Mathematics Curriculum, Index Function.**

I. INTRODUCTION

The rapid development of modern information technology, especially computer science, has a great impact on the traditional mathematics teaching. The integration of information technology and high school mathematics curriculum provides more abundant contents for classroom teaching, promotes the reform of mathematics teaching, promotes the development of middle school mathematics curriculum, and also incorporates more learning resources into high school mathematics classroom teaching. The effective integration of modern information technology and high school mathematics teaching curriculum can help us to make abstract things concrete and vivid by using modern educational technology to assist teaching, avoid the phenomenon of memorizing knowledge by rote, embody the subjectivity of students' learning, and help students with modern educational technology. Construct their own cognitive structure and ways of thinking, in full mobilization of all senses, more visualized memory.

The relevant requirements for the content of exponential function in the Mathematics Curriculum Standards for Senior High Schools (2017 Edition) are: (1) Understanding the meaning of rational exponential power $a^{\frac{m}{n}}$ ($a > 0$ and $a \neq 1$; m, n are integers and $n > 0$), real exponential power a^x ($a > 0$ and $a \neq 1$; $x \in R$) to understand the process of exponential power expansion and grasp the operation nature of exponential power. (2) Understand the practical significance of exponential function and the concept of exponential function through specific examples. (3) The image of specific exponential function can be drawn by point tracing or by means of calculating tools,

and the monotony and special points of exponential function can be explored and understood. (4) In the process of solving simple practical problems, we realize that exponential function is an important functional model [1].

Function is an important mathematical model describing the changing law of the objective world. Through the study of specific functions such as exponential function, students can deepen their understanding of the concept of function. The most important thing is to encourage students to use modern educational technology to study, explore and solve problems, such as drawing exponential functions with calculators and computers, exploring, comparing their changing laws, and studying the nature of functions.

II. Equipped with Teaching Materials

The textbook used is Mathematics Compulsory Course Standard Textbook A for Senior High School published by People's Education Publishing House. The content is 2.1.2 exponential function and its properties in Chapter II Basic Elementary Function (I).

Exponential function is the first basic elementary function newly introduced in senior high school. Therefore, the textbook first gives the actual background of exponential function, then it gives a complete introduction to the establishment of the concept of exponential function, the drawing of the image of exponential function, the discovery of the basic properties of exponential function and the preliminary application of exponential function. Exponential function is one of the key contents of this chapter. The contents of instructional design are exponential function image and its properties.

III. Analysis of Learning Situation

In junior middle school, students have preliminarily explored simple functions such as positive proportional function, inverse proportional function, primary function, quadratic function, etc. They have a certain perceptual understanding of the function, and have a preliminary understanding of the meaning of the function. With the help of lists and descriptions, we can draw pictures, observe and imagine, and get an intuitive understanding of the basic properties of functions. In senior high school, students have learned to describe the dependence between variables and the concept of function with set and corresponding language. On this basis, the general method of studying the nature of function is discussed. In the second chapter, students have completed the expansion of the range of index values, and have the ability of exponential operation, which is the learning of this lesson. It laid the foundation. In this lesson, students are helped to further understand the function, to familiarize themselves with the thought and method of function, and to initially cultivate their consciousness of function application, so that they can gradually acquire more systematic knowledge of function [2].

IV. Teaching Purpose

1. *Knowledge and Skills:*

Grasp the image of exponential function; grasp the nature of exponential function; cultivate students' abilities of practical application of function.

2. *Processes and Methods:*

By observing images, analyzing, summarizing, and summarizing, the nature of self-constructed function is discussed. Understand the combination of numbers and figures, classified discussion and general mathematical

thinking methods, and cultivate students' abilities to discover, analyze and solve problems.

3. *Emotions, Attitudes and Values:*

In the learning process of exponential function, animation demonstration enables students to more intuitively feel the image of exponential function, cultivate students' abilities to find, raise, analyze and solve problems, and build a harmonious classroom atmosphere. Experiencing the scientific value and application value of mathematics, cultivating students' good habits and rigorous scientific spirit of being good at observation and exploration, and feeling that mathematics comes from life and it is applied to life. It is also to cultivate the core quality of students' intuitive imagination.

V. TEACHING DESIGN PROCESS

Teacher: We defined a new function in the last lesson-exponential function: $y = a^x \left(a > 0 \, 且 \, a \neq 1\right)$. According to the basic theory of functions we have learned, what are we going to study next?

Student: Studying the image and properties of exponential function.

Teacher: Generally, what properties of functions do we study?

Student: Range of variables (definition range, range), monotonicity, parity.

Teacher: How to study these properties?

Student: First, draw the image of exponential function, observe the image and analyze the properties of the function.

Student: First we study several specific exponential functions, then we study the general situation.

a. *Selection of Data*

Design Intent:

Choosing data refers to the data that students choose the base number a independently. In order to study the properties of functions, the selection of data should be representative. Some students may have a passive understanding of the image if the teacher sets the value of the base directly or decides the value of the base after discussion. Let students choose the base number independently, although it is possible to get a one-sided understanding, but it leaves room for students to think, which is conducive to mobilizing students' enthusiasm for independent learning. Through collaborative communication, students can complement each other, verify the conclusions together and get a complete understanding. Students choose the base number independently, which requires students to make a preliminary analysis of the exponential function. It is helpful for students to feel the method of data selection and understand the process of research.

In the actual teaching, some students put forward the selection function $y = 2^x$ and $y = 0.5^x$, the reason is: since the bottom number is also $a > 0$ and $a \neq 1$, then choose a positive number less than 1 as the bottom number, and then choose a base number greater than 1.

This view is unanimously accepted by students. In fact, such students have a preliminary understanding of the nature of the exponential function.

b. *Drawing Pictures*

Let the students draw the function and image in the same rectangular coordinate system with the method of point tracing. Students list:

Form 1

x	-3	-2	-1	0	1	2	3
y	0.125	0.25	0.5	1	2	4	8

Form 2

x	-3	-2	-1	0	1	2	3
y	8	4	2	1	0.5	0.25	0.125

Then the teacher uses the software-super sketchpad, to demonstrate the process of drawing functions with the method of drawing points.

[*Operating Steps*]

(1) In the attributes dialog box of coordinate system, select the options of "drawing coordinate grid" and "displaying scale".

(2) Click the menu item "Drawing function or parametric equation curve..." Pop-up function drawing property dialog box; Enter: 2^ X in the edit box corresponding to "y = ", and then set "Points of Curve" as follows: 7, set the parameter range of variable x as follows: -3 to 3, select "Points" on the broken line segment, and set the size of the point as follows: 2: Finally click the "OK" button to complete.

(3) Click the menu item "Insert | Text..." In the pop-up text editing properties dialog box, enter y = 2 ^ x, and then click the OK button to exit.

After the operation, let the students take the initiative to participate in the completion of the image production. The results are as follows:
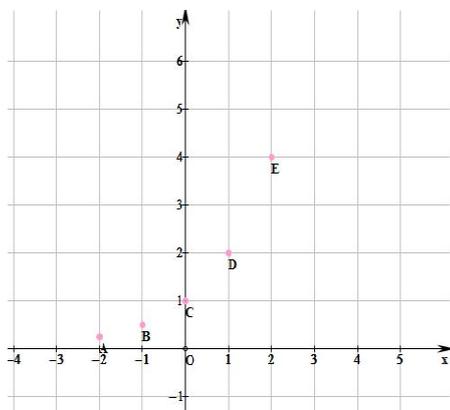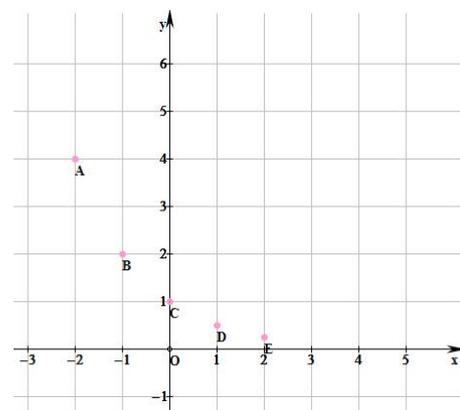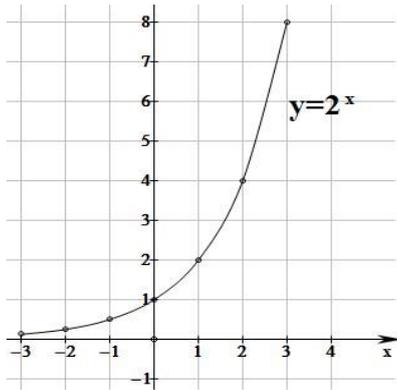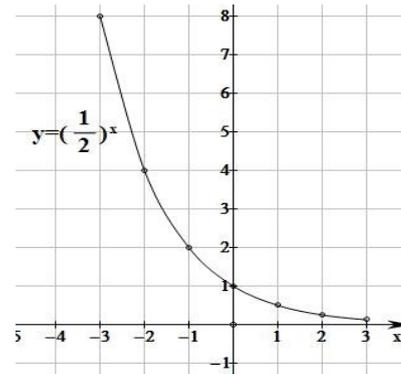

Fig. 1.

Fig. 2.

Fig. 3.   Fig. 4.

Design Intent:

Teachers should pay attention not only to the exponential function image itself, but also to the thinking process of the combination of numbers and figures in the process of drawing. Students have a preliminary understanding of the nature of exponential function by calculating specific data in the process of listing. For example, when students draw the image of the function in the list, they find that when x is a positive integer, the latter value is twice as much as the former value, and the impression that the function is monotonously increasing is preliminary obtained.

c. *Observational Characteristics*

Teachers use Super Sketchpad to draw the exponential function image whose base number is greater than 1 and whose base number is greater than 0 and less than 1 in the coordinate system to demonstrate the process of exponential function image change.

[*Operating Steps*]

(1) In the attributes dialog box of coordinate system, select the options of "drawing coordinate grid" and "displaying scale".

(2) Click the menu item "Drawing function or parametric equation curve..." Pop-up function drawing property dialog box; enter a ^ X in the edit box corresponding to "y = ", and then set the "points of curve" as: 50 in the following curve property, set the parameter range of variable x: -6 to 6, set the size of the point as: 2: click the button to finish.

(3) Select the curve, click the menu item "Drawing" and select the "Tracking" option.

(4) Right-click the animation, and "variable name" input: a, click the "OK" button, the frequency of animation movement: 100; the minimum range of parameters is 0, the maximum value is 5; type: one movement; milliseconds to 50.

(5) Click the menu item "Measure", select the "Value of Variables" option, "Measure Variables" input: a, click the "Determine" button.

(6) Click the menu item "Insert | Text..." In the pop-up text editing properties dialog box, enter y = a ^ x, and then click the OK button to exit [4].
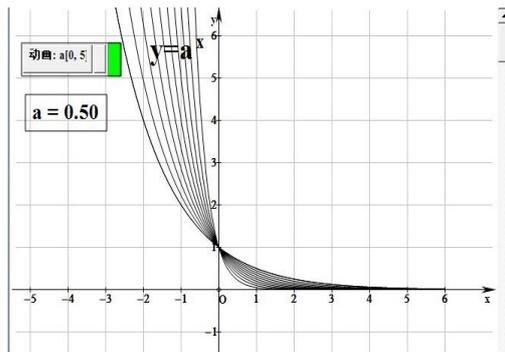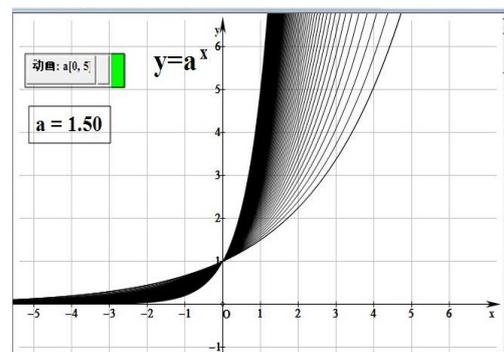
The Results are as Follows:
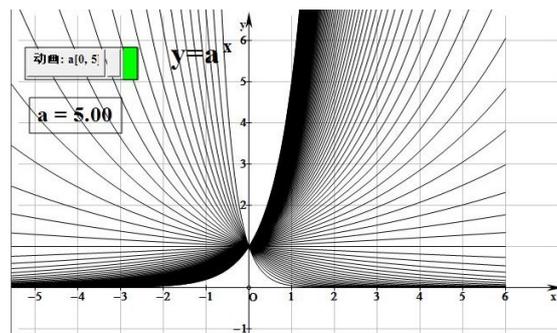

Fig. 5.

Fig. 6.

Fig. 7.

Design Intent:

Student's observation of images is the understanding of graphic language. According to the nature of image description, graphic language is transformed into symbolic language or written language. Teachers should guide students to pay attention to the "change" and "invariability" of different exponential function images, combine the intuitive perception of function images with mathematical rational thinking, and properly explain or prove the conclusions obtained from observation. In this process, students are helped to generalize the properties of general exponential functions from the properties of specific exponential functions.

d. *Inductive Nature*

Form 3

	$0 < a < 1$	$a > 1$
Definition domain	**R**	
Range	$(0, +\infty)$	
Nature	Over-fixed point (0,1),When x = 0, y = 1	
	On R is a subtractive function.	On R is an incremental function.

The correctness of the properties derived from the induction needs to be verified. In this lesson, on the one hand, the students can be guided to explain the properties of exponential functions from the analytic expressions, such as the definitions of exponential functions, the ranges of values and the over-fixed points (0, 1) of images. On the other hand, modern educational technology can be used to further embody the idea of combination of numbers and shapes, such as monotony of exponential function, through dynamic image verification.

VI. TEACHING CHARACTERISTICS

Using the idea of combination of numbers and shapes to learn the image of exponential function and its nature, students observe the image, which is the understanding of graphic language; according to the nature of image description, it is to transform graphic language into symbol language or written language, accumulate experience in mathematical activities, cultivate students' core literacy of visual imagination, and emphasize students' hands-on exercises. In order to promote students' active learning and improve their ability to analyze and solve problems, textbooks attach great importance to providing students with opportunities for hands-on operation and active participation. In the process of image of number function, the textbook does not provide a complete table of corresponding values of independent variables and function values, but leaves blanks for students to fill in [5].

At the same time, it also embodies one of the basic concepts of the new curriculum standard, that is, to actively explore the integration of mathematics curriculum and information technology. When drawing exponential function images by point tracing and exploring exponential function and its properties, Super Sketchpad is used to help students understand more intuitively what they have learned. Properly embody the application of modern information technology in order to better play the role of information technology, provide students with powerful cognitive tools to explore and understand the nature of mathematics independently, and strengthen the integration of information technology and curriculum content [6].

VII. TEACHING EFFECT

The teaching content of this lesson refers to the image and property of exponential function. In the process of teaching, modern educational technology is used to help students grasp the image characteristics and properties of exponential function. Applying modern educational technology to assist teaching can stimulate students' learning interest and thirst for knowledge. Interest is the best teacher for students. As the source of motivation, interest plays a vital role. How to combine classroom knowledge with students' interest and stimulate students' learning enthusiasm is the first evaluation. The use of modern educational technology makes this standard easier to achieve. Modern educational technology presents words and graphical sounds in front of students, which can be more real and flexible in transforming knowledge into a form that students like. Using modern educational technology to assist teaching can speed up students' learning efficiency, make students better memory, mobilize students' senses comprehensively and devote themselves to learning. It can not only attract students' attention, but also create a good learning atmosphere and situation, so that students can have a good empathy to the teaching content. Visualized memory of classroom content, stimulate association to speed up the process of memory. It can help students better understand the image and nature of exponential function, the influence of base number on the change of function value, the nature and application of exponential function, and grasp the key and difficult points.

VIII. REFLECTIONS

Teachers should learn to let students participate, question, think, discuss, cooperate, communicate and show. Through inquiry activities and using modern educational technology, students can grasp the image characteristics and properties of exponential function and make them study actively. Teachers should let students go, return time to students, and return the classroom to students, which is the basic requirement for teachers to have a good class. Encourage students to participate in activities boldly, to show themselves actively and to show themselves.

IX. Conclusion

In a word, the integration effectiveness of modern information technology and high school mathematics curriculum is a systematic project, which requires us to practice, explore and summarize constantly. We should not only regard information technology as the object of learning, but also as the tool of learning. We should strive to achieve the integration of information technology and curriculum, and realize the fundamental change of teaching and learning methods.

Reference

[1] Formulated by the Ministry of Education of the People's Republic of China. Mathematics Curriculum Standards for Senior High Schools 2017 [M]. Beijing: People's Education Press, 2018.01, p20.

[2] Editor-in-chief of Xu Hanwen. Analysis of Mathematics Curriculum Standards and Textbooks for Middle Schools [M]. Beijing: Science Press, 2014.01.

[3] Liu Yanyong. Teaching Design of Exponential Function [J]. Mathematics and Physics Learning (Senior High School Edition), 2019 (No. 4).

[4] Li Chuanzhong, Zuo Chuanbo. Super Sketchpad Example Course [M]. Beijing: Science Press, 2004.10, p179.

[5] Long Aihong. Research and Practice on Integration of Modern Educational Technology and High School Mathematics Course [J]. Contemporary Educational Practice and Teaching Research, 2018, (04).

[6] Yu Shengquan, Chen Li. Basic Characteristics of Effective Integration of Information Technology and Curriculum [J]. Information Technology Education in Primary and Secondary Schools 2005 (4).

[7] Hou Cungui, Xing Wei. Research on Integration of Information Technology and Mathematics Curriculum in Senior High Schools [J]. Yinshan Journal, 2015, (01): 88.

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