

An Exploration on the Teaching Practice of "Preliminary Geometry" with NetPad——A Case Study of Class A, Grade 7, Fengtai Middle School, Beijing National Day School

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Abstract: In order to adapt to the development trend of education informatization, academician Zhang Jingzhong of the Chinese Academy of Sciences led his team to develop China's first professional mobile Internet dynamic mathematics software on the basis of Supersketchpad, named NetPad, which is mainly used to serve science teaching. This paper takes the students of Fengtai Middle School of Beijing National Day School as the experimental objects, and uses the research methods such as questionnaire survey and test to collect the main data of the research process. Two classes were randomly selected to participate in the teaching experiment. The research results show that the NetPad assisted junior middle school mathematics "figures and geometry" teaching can better mobilize students' interest in mathematics, improve junior middle school students' understanding ability of plane geometry, develop their spatial imagination ability, exercise their thinking ability, master good learning methods, improve junior middle school mathematics "figure and geometry" problem solving ability, and achieve better grades and better learning results.

Keywords: NetPad, junior high mathematics, figures and geometry, experiment and research

1. Experiment scheme

1) Experiment purpose

Through the experimental research on the application of NetPad in the "preliminary geometry" teaching of junior middle school mathematics, this paper analyzes the effect of NetPad applied in junior middle school mathematics "preliminary geometry" classroom teaching, and verifies the effectiveness of NetPad applied in junior high mathematics "preliminary geometry" teaching by comparing with the teaching effect of traditional teaching methods. [1-3]

2) Experiment tools

Table 1: Reliability analysis of each dimension of the survey scale

Dimension	Cronbach's α coefficient
Interest in mathematics learning	0.785
Understanding ability of plane geometry	0.764
Spatial imagination	0.803
Mathematical thinking ability	0.814
Geometry learning methods	0.823
Learning effects	0.796
Overall questionnaire	0.806

In order to verify the two groups of students' learning of junior middle school mathematical geometry and graphics knowledge, survey questions were designed from the dimensions of learning interest in mathematics, understanding ability of plane geometry, spatial imagination ability, mathematical thinking ability, geometry learning methods and learning results. These questions provide the basis for the analysis of the teaching effect of geometric sketch board applied to the geometry and graphics of experimental class. In this questionnaire survey, the students of Class 1 (2) of the experimental class were selected as the objects, a total of 52 questionnaires were sent out, and 51 were effectively filled in with the effective collection rate of 98.08%.

In order to ensure the validity of the questionnaire content, the author used SPSS20 statistical analysis software to test the reliability and validity of the questionnaire after finishing the collation of the questionnaire data. Cronbach's α coefficient method was used for reliability test, and the results showed that the α coefficient values of the whole questionnaire and all dimensions were above 0.7, which met the verification criteria for questionnaire reliability, indicating that the data collected by the questionnaire used in this paper had good internal consistency and the stability of the survey results was good, as shown in Table 1.

Exploratory factor method was used to test the validity of the questionnaire. First, Bartlett's test was used to verify the correlation between each item in the questionnaire. The results showed that when Bartlett was less than 0.05, the conditions for the factor analysis were met. Subsequently, the KMO value was used to determine whether the questionnaire was suitable for factor analysis. The results showed that the KMO value of 0.827 was greater than 0.7, which was more suitable for factor analysis. The results were shown in Table 2.

Table 2: Results of KMO and Bartlett's test

KMO Value	0.827
The value of Bartlett's test	4927.253
df	171
Significance	0.00

Then, SPSS20 statistical analysis software was used to analyze the commonality of questionnaire items, and the results showed that the factor loading of each item in the questionnaire was greater than 0.5, indicating that the extraction of research information was effective. The factors of each item were rotated to highlight the differentiation of factor load, and the factor attribution of different variables was presented. The results showed that the corresponding relationship between each item and the research dimension was in line with expectations, and the validity of the questionnaire passed the test.

2. Teaching Design -- The Determination of Rhombus

Review knowledge and introduce a new lesson:

Module 1		
Teaching process	Teaching activity	Student activity
Teaching Link 1: Review knowledge and introduce a new course	Question 1: We have learned about parallelograms and rhombuses in the previous class. So, what is a parallelogram? What is a rhombus? Question 2: What are the ways to determine a parallelogram? When exploring the method of rhombus determination, is it possible to compare it with the method of parallelogram determination?	Students think independently and answer questions. A quadrilateral with two opposite sides parallel is a parallelogram; A parallelogram with equal adjacent sides is a rhombus; Determination method of parallelogram: (1) A quadrilateral whose opposite sides are respectively equal (2) A quadrilateral whose opposite angles are respectively equal (3) A quadrangle whose diagonals bisect each other (4) A quadrilateral with a set of opposite sides parallel and equal Based on the determination method of parallelogram, we explore the determination method of rhombus from the diagonal and edge.
Module 2		
Teaching process	Teaching activity	Student activity
Teaching Link 2: Gain new knowledge through Cooperative inquiry	Exploration activity 1: Fix two wooden strips at the midpoint and tie rubber bands around the strips to form a quadrangle. Under what circumstances can a rhombus be obtained by turning the wood? Exploration activity 2: Draw two line	Student activity Program: Exploration activity 1: The students in the class were divided into 10 groups, including 9 groups with 5 members and the other group with 6 members. In each group, a leader is set up who organizes the students in the group to explore. In this activity, the corresponding

	<p>segments AB and AD on the paper. Then, draw a circle according to radius AB, using point B as the center of the circle. Draw another circle with D as the center and AD as the radius. Let's call the intersection of two circles point C. After the C point is determined, connect BC and CD to obtain the ABCD graph. What kind of quadrilateral is this? Can you summarize the method of determining the rhombus?</p>	<p>experiment can be carried out with the help of the NetPad, and the corresponding conclusion can be obtained, namely: the parallelogram whose diagonals are perpendicular to each other is a rhombus.</p> <p>Exploration activity 2: Students are required to draw according to the activity content, and guess and discuss the final drawing. In the teaching process, teachers can use the NetPad to draw graphs, and students can guess and prove it. It follows that a quadrangle with four equal sides is a rhombus.</p>
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Activity exploration 1: Students should prepare corresponding materials before class, but the preparation will waste most of their time and delay the actual teaching progress. On this basis, we can give full play to the value and advantages of the NetPad by using it to simulate the whole experiment process. As shown in Figure 1, AC and BD are wood strips, and ABCD are quadrangles enclosed by rubber bands; the quadrangles can be changed by dragging point A or point B to rotate the wood strips. In the known conditions of exploring activities, it is already known that point O is the midpoint of AC and AB. Now what kind of parallelogram is a rhombus is to be explored, according to the decision theorem of parallelogram, that is, the formed quadrilateral is already a parallelogram. By rotating the wood, i.e. changing the angle between AC and BD, it is possible to judge whether it is a rhombus by finding the size of $\angle AOB$, and this needs to consider the definition of a rhombus. Therefore, in the experiment process of verification, it is necessary to measure the size of $\angle AOB$ and the length of AB and AD, so that the verification of the guess can be carried out, that is, when the $\angle AOB = 90$, that is, the diagonals of the parallelogram are perpendicular to each other, $AB=AD$, it can be verified that the parallelogram whose diagonals are perpendicular to each other is a rhombus.

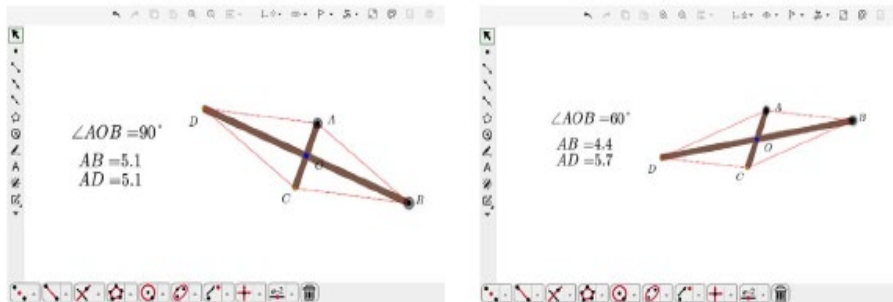


Figure 1: NetPad operation demonstration

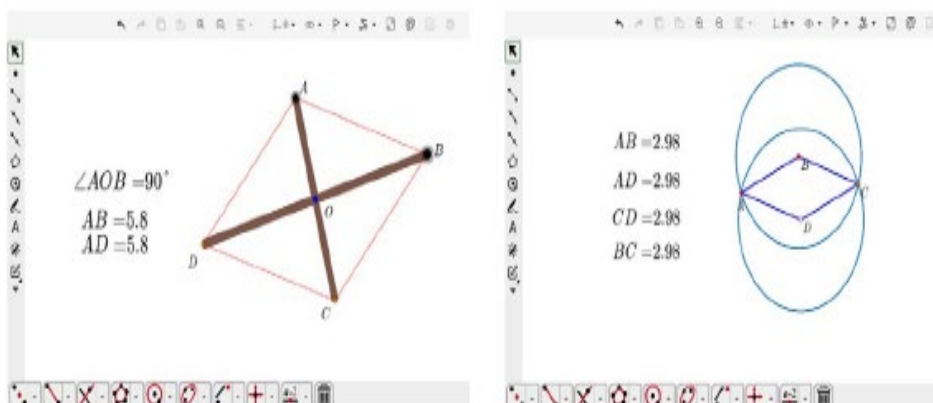


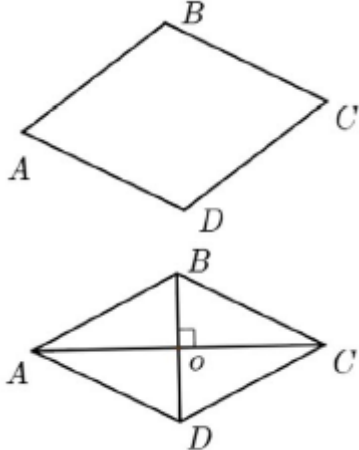
Figure 2: NetPad operation demonstration

Exploration Activity 2:

In the teaching process, the exploration is carried out in groups. Each group assigns one member to push point A or B. In this way, students can enhance their sense of participation and realize that if the diagonal is not vertical, no matter how they change point A or B, the adjacent sides cannot be equal. In

this experiment, BD can also be dragged to achieve the adjustment of the length of line segment BD and AC. However, when $\angle AOB = 90^\circ$, AB is the same length as AD no matter how you drag it, as shown in Figure 2. In the whole teaching process, if the teacher uses wooden strips according to the requirements of exploration activity 1 and change the length of wooden strips in class, it will take a long time though it is possible to be realized. After the introduction of NetPad, teaching simulation can be carried out, which not only significantly improves the operability, but also has no impact on the authenticity, and at the same time can obtain unexpected teaching effects.

By exploring and concluding, the theory is proved:

Module 3		
Teaching process	Teaching activity	Student activity
Teaching Link 3: By exploring and concluding, the theory can be proved	In the last lesson, we obtained two theorems of rhombus. Please express it in a graphic language and prove it. 	Student activity scheme: Divide the students in the class into two groups and prove two theorems respectively. When the students finish, communicate with them. You already know: in $\square ABCD$, diagonal AC and BD intersect at point O, $AC \perp AD$. Verification: $\square ABCD$ is a rhombus. Prove: \therefore quadrilateral ABCD is a parallelogram $\therefore OA = OC$ $\therefore AC \perp AD$ \therefore BD is the perpendicular bisector of line AC $\therefore AB = AC$ $\therefore \square ABCD$ is the diamond Already know: in quadrilateral ABCD, $AB=BC=CD=AD$ Prove quadrilateral ABCD is a rhombus: $\therefore AB=BC=CD=AD$ $\therefore AB = CD, BC = AD$ \therefore parallelogram ABCD is a parallelogram Also $\therefore AB = AC$ $\therefore \square ABCD$ is a rhombus

In the first question, students can answer the questions orally, so as to improve students' language expression ability. It is sort of difficult to use the theorem "quadrilateral whose diagonals are perpendicularly bisected to each other is a rhombus" to judge. In this process, students can be guided to judge the parallelogram first, and then judge the rhombus after determining the figure as a parallelogram. The purpose of question 2 is to cultivate students' logical thinking ability, because in the proving process, we have realized that the figure is a parallelogram, and we can effectively judge whether the parallelogram is a rhombus only by judging whether the diagonal of the parallelogram is vertical. In the third question, it is to investigate the theorem "a quadrilateral with four equal sides is a rhombus". Through the above three questions, it can better realize the enhancement of students' expression ability, improve students' exploration ability, as well as promote the improvement of students' logical thinking ability.

Module 4		
Teaching process	Teaching activity	Student activity
Teaching Link 4: Apply theorems to consolidate new knowledge:	1. Are the following statements true? Why? (1) A quadrangle whose diagonals are perpendicular to each other is a rhombus. (2) A quadrangle with four equal sides is a rhombus. (3) A quadrangle whose diagonals bisected perpendicularly is a rhombus. 2. In the figure below, diagonal AC and BD intersect at the point O, $AB=5, AC=8, BD=6$ in the $\square ABCD$. Then, try to prove ABCD is a rhombus. 3. In the equilateral triangle ABC, D, E and F are the midpoints of each side respectively, and connect DE, EF and DF. Try to prove quadrilateral BDEF and CEDF are	1. Answer the first question orally and discuss it in class. 2. The second question needs to be explained by the teacher, and the process needs to be written on the blackboard, in order to demonstrate. 3. The third question is to be answered by students themselves, and 4

	rhombuses. 	students are selected to write their answers on the blackboard. Among them, 2 students prove quadrilateral BDEF and the other 2 students prove quadrilateral CEDF.
Module 5		
Teaching process	Teaching activity	Student activity
Teaching Link 5: Try to summarize and assign a homework	Summary: 1. In this lesson, what methods have we learned to determine a rhombus? 2. Where haven't you understand in this lesson? Homework: Required: 1. Question 1 and 2 of exercise 1.2 on page 7. Optional exercise: 2. If the triangles in question 3 were not equilateral triangles, would the two quadrilateral shapes still be rhombuses? Why?	Students and teachers summarize together; Complete the homework independently.

3. The analysis of the results of the NetPad applied to the "preliminary geometry" teaching experiment of junior high mathematics

1) Analysis of mid-term math test scores of experimental class and comparing class before the experiment (Table 3)

Table 3: Analysis of mid-term math test scores of experimental class and comparing class before the experiment

	Class	Number of students	Mean score	Standard deviation	Standard error of the mean
Mid-term test scores before the experiment	The experimental class	51	85.1000	10.74534	1.42072
	The comparing class	50	84.9200	10.05323	1.32794

Before the teaching experiment was carried out, the students' achievements in the two classes were tested first, and the results obtained were: 85.1 points in the experimental class and 84.92 points in the comparing class. The independent sample t test showed that the significance was $0.542 > 0.05$. It can be seen that the corresponding difference between the two groups of students in mathematics achievement is not significant. $P=0.935 > 0.05$, indicating that there was no significant difference between the two groups of students in the 95% confidence interval. Based on this, the two classes can be taken as parallel classes to carry out corresponding teaching research in the research process.

Table 4: The independent sample test of the mid-term math test scores of experimental class and comparing class before the experiment

Pre-experiment test scores	Levene test					T test for equality of means			
	F	P	T	degree of freedom	two-sided significance test	The average value	Standard deviation value	95% confidence interval for the deviation	
								Upper limit	Lower limit
	.375	.542	.086	98	.935	.18000	2.08162	-3.95050	4.31090
			.086	97.565	.935	.18000	2.08162	-3.95113	4.31113

2) Analysis of mid-term math test scores of experimental class and comparing class after the experiment

After 3 months of experimental teaching, the math scores of students in the two classes was analyzed, and the results were shown in Table 5 and Table 6. First, the comparison results before and after the experiment show: In the t test of independent samples, $\text{sig}=0.008 \leq 0.01$. Based on this, variance heterogeneity can be assumed. $p=0.001 < 0.01$, which means that H_1 is accepted and H_0 is

rejected at the significance level of 0.01, that is, there is a significant difference between students' scores before and after the experiment. It can be concluded that in the process of mathematics teaching, the introduction of NetPad can realize the strengthening of students' mathematics achievement.

Table 5: Comparative analysis of pre & post experiment test scores of students in comparing class

	Class	Number of students	Mean score	Standard deviation	Standard error of the mean
scores of comparing class	pre-experiment test	50	85.1000	10.94994	1.42772
	post - experiment test	50	86.2200	10.72311	1.43547

Table 6: Independent sample test of p pre & post experiment math scores of students in comparing class

Scores of comparing class	Levene test					T test for equality of means			
	F	P	T	degree of freedom	two-sided significance test	The average value	Standard deviation value	95% confidence interval for the deviation	
								Upper limit	Lower limit
	.219	.641	-.539	98	.592	-1.12000	2.06757	-5.24485	3.00485
			-.539	97.523	.592	-1.12000	2.06757	-5.24510	3.00510

Table 7: Comparative analysis of post-experiment test results between comparing class and experimental class

	Class	Number of students	Mean score	Standard deviation	Standard error of the mean
Post-experiment test scores	Comparing class	50	86.2200	10.11301	1.51747
	Experimental class	51	90.7600	6.64217	.84343

Table 8: Independent sample test of pre & post experiment math scores of students in comparing class

Post-experiment test scores	Levene test					T test for equality of means			
	F	P	T	degree of freedom	two-sided significance test	The average value	Standard deviation value	95% confidence interval for the deviation	
								Upper limit	Lower limit
	9.087	.003	-2.658	98	.008	-4.54000	1.62829	-7.94004	-1.14996
			-2.658	85.804	.008	-4.54000	1.62829	-7.93004	-1.14393

In the comparing group, the comparison of students' math scores before and after the experiment showed that $\text{sig} = 0.641 > 0.05$, so homogeneity of variance was assumed. According to the T-test, $p = 0.591 > 0.05$, which means that there is little difference between the math scores of students in the comparing group before and after the experiment. That is to say, using traditional teaching methods for teaching, student achievement has not changed greatly, as shown in Table 7 and 8.

After the completion of the 3-month teaching experiment, the math scores of the two classes were tested as follows: the average score of the control class was 86.22; The experimental class scored 90.76. The t test of the samples showed that $\text{sig} = 0.003 < 0.01$ and $p = 0.009 < 0.01$, that is, H_1 was accepted and H_0 was rejected at the significance level of 0.01. It can be seen that after the completion of the experiment, the results of the two groups of students are significantly different. That is to say, compared with the comparing group, students in the experimental class have higher math scores, which means that the introduction of NetPad teaching can realize the strengthening of students' math scores to a certain extent.

4. Conclusion and prospect

1) Conclusion

By integrating the following three aspects of information: the pre & post test results, the performance of students in the class, and the student questionnaire, the following conclusions can be obtained:

According to the pre & post test results, it can be seen that students' results have been improved to a certain extent by NetPad teaching. [4-6]

According to the students' class performance and the questionnaire results, it can be seen that the NetPad is favored by students in the class application process. For the teachers, the class atmosphere is more relaxed and happy when they carry out teaching tasks with NetPad, and most of the students suggest that the courseware is novel and interesting. Compared with the monotonous classroom teaching in the past, the current classroom is more able to attract students' attention and stimulate their desire to learn. At the same time, with the help of the NetPad, teachers can vividly display the boring and difficult geometric figures through geometric animation, and help students better understand and master them. [7-8]

2) Prospect

The NetPad is an effective tool to optimize the teaching effect of mathematics subject, but it has not been popularized in the junior middle school mathematics "figure and geometry" teaching. Through experiments and researches, this paper verifies the application effect of NetPad in junior high mathematics "figure and geometry" teaching, which can provide some references for front-line teachers and promote the application of NetPad in junior high mathematics "figure and geometry" teaching.

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