ISSN 2616-5805 Vol. 4, Issue 5: 16-22, DOI: 10.25236/AJMS.2023.040503

Research on the influence strategies of high school students' ability to solve functional problems in wisdom classroom

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Abstract: *In order to study the strategic impact of high school students' ability to solve functional problems in the wisdom classroom, high school students in N city and A county were randomly selected for investigation and research. The types of functional problem-solving strategies were coded and the data were processed using hybrid research method and qualitative analysis method. The results show that 59% of students with good grades use calculation strategy and reasoning strategy; 17% of students with average scores tend to use reasoning strategies, followed by meta-strategies; 24% of students with lower grades used only meta-strategies. Based on this, the author puts forward some suggestions for teachers' reference.*

Keywords: *Wisdom classroom; Function; High school mathematics; Strategy research*

1. Introduction

The Mathematics Curriculum Standards for Compulsory Education (2022 edition) points out that modern information technology should be used rationally, rich learning resources should be provided, and vivid teaching activities should be designed to promote the reform of mathematics teaching methods [1]. The Ministry of Education promulgated and implemented the "Senior High School Mathematics Curriculum Standards (2017 edition)", which made it clear that attention should be paid to the requirements of information technology and mathematics curriculum: the extensive application of modern information technology is having a profound impact on the content of mathematics curriculum, mathematics teaching and mathematics learning; It is also suggested that we should use geometric intuition and spatial imagination to understand and solve mathematical problems. Therefore, first of all, we should create a reasonable information learning environment to improve students' information literacy; Secondly, teachers should pay attention to cultivating students' intuitive imagination ability, so that students can perceive changes through images and describe function problems clearly when learning function knowledge.

In 2011, James Dooley and his team in the United Kingdom began designing smart classrooms. At present, compared with traditional computer classrooms, London, Birmingham, Edinburgh and other cities have embedded multi-modal sensors in the learning space of smart classrooms, with advantages such as intelligent prediction, all-round sensing, personalized push, timely interaction and so on [2].

Domestic research shows that most countries have mentioned educational informatization in their education development strategies. Professor Zhu Zhiting defines the concept of smart education: Smart education refers to the integration of information technology and teaching in the background of education informatization, cultivating man-machine collaborative teaching wisdom and data wisdom, and providing personalized learning services and development experience for learners based on the principles of precision, individuality and creation, so as to cultivate modern talents with good thinking quality and strong creative ability [3]. According to Tang Yewei et al., smart classroom is a revolution that changes the traditional classroom teaching mode, integrates modern information technology with classroom teaching, and adopts intelligent and personalized classroom teaching mode. Some scholars believe that different subject contents are taken as examples to build smart classroom teaching models before, during and after class, and emphasize the role of intelligent technology in the process of providing digital resources, creating learning scenarios, breaking through difficult problems, and reflecting on learning

ISSN 2616-5805 Vol. 4, Issue 5: 16-22, DOI: 10.25236/AJMS.2023.040503

content [4].

Function is an important mathematical language and tool to describe the relationship and law of variables in the objective world. Function images more intuitively explain the understanding of the concept of function. Animation software or actual models are used to enable students to deeply understand the image and property of function, and express the change relationship between function and analytic expression of equation [5]. Function is an indispensable part of high school mathematics study, from the concept of function to the property, image and analytic solution should fully grasp the knowledge points. Image representation can simplify and help solve high school math problems, and it is also an important part of solving function problems, helping students to analyze problem meaning, grasp key points and clarify ideas. However, when and how to use images to solve problems, students still cannot have a better understanding [6].

Therefore, the research mainly focuses on the following three questions: First, what is the current situation of function problem solving under the wisdom class of high school students? Second, what is the relationship between students' ability to solve functional problems and the influence of teachers' use of wisdom classroom? Third, how do test scores based on surveys affect strategies for solving functional problems?

2. Research Methods

The mixed research method is mainly used to investigate the current situation of high school students in N city and A county using wisdom classroom to solve function problems in the form of test, and to analyze the correlation of the ability to solve function problems in high school under wisdom classroom. Qualitative analysis is used to study the influence of high school students' strategy of solving functional problems in the wisdom classroom model.

2.1 Research Methods

This study takes high school students in N City and A county as the research object, and investigates the natural situation of high school students and teachers using the smart classroom function, which is representative. A total of 400 questionnaires were designed, of which there are about 6,000 students in Grade one, grade two and grade three of the school. 380 students were randomly selected for stratified sampling, and their scores were selected from the top, middle and bottom three levels to understand the situation of thematic tests under the wisdom classroom and the accuracy rate of the hand-drawn drawing answering function topic.

2.2 Research Methods

This study analyzed the function topics in the wisdom classroom and the situation of answering questions by drawing pictures by hand, and designed A targeted questionnaire survey, which was distributed to 160 teachers and 380 students in the senior middle school of N City and A county. The questionnaire was collected at the end of the time to ensure that the personal information of teachers and students was not leaked, and the survey results were counted at the first time.

2.2.1 Wisdom classroom and function problem test paper

Based on the test paper of Peter M G M Kop and other scholars, and under the guidance of university mathematics education scholars and front-line teachers with rich teaching experience [6], the test is set into two parts, with a total of 17 questions. The first part is about function problems, including three types of problems: the first problem is tangential problem, the second problem is zero existence problem, the third problem is related to inequality proof problem; The second part, questions 4 to 17, is a test paper for solving function problems under the wisdom class, in which students are asked to use the wisdom platform to answer questions.

Before the questionnaire was distributed, the reliability and validity were tested. In this study, the questionnaire data was imported into IBM SPSS Statistics 22.0, and important variable attributes were defined and designed to ensure the accuracy of the test. According to the validity evaluation, factor analysis is suitable when KNO is greater than 0.9(see table1).

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Table 1 KMO and Bartlett tests

Kaiser-Meyer-Olkin test for sampling adequacy	.796
Bartlett's sphericity test is about chi-square	1793.478
Df	314
significance	.034

According to SPSS Table 1, the statistical value of the Bartlett sphericity test of this questionnaire is 1793.478, and its corresponding probability value is 0.034. At this significance level, the null hypothesis is negated and the correlation coefficient is considered to be significantly different from the unit matrix. At the same time, the KMO value was 0.796, indicating that the questions set by the questionnaire were suitable for factor analysis.

Table 2 Summary of observed processing

	N	%
Observed validity	392	100.0
Ruled out	0	.0
statistics	392	100.0

Table 3 Reliability statistics

Cronbach'Alpha	Number of items
.811	20

According to the reliability analysis of SPSS, Cronbach Alpha value is 0.811, which belongs to the internal consistency coefficient, and its value is greater than 0.8, indicating good reliability of the scale(see table 2,3).

2.2.2 Coding of solving strategies for functional problems

Based on the coding framework of Peter McKop et al. [7], it is used as a clustering analysis tool for high school students to use wisdom classroom to influence functional problem-solving strategies(see table 4).

Table 4 Encoding of problem-solving strategy types

type	*strategy*	*Coding specification*
S2	*Recognition feature strategy*	*Recognition of images and usage features;*
J	*Recognition of images and usage features;*	*The problem is solved mainly by inference identification and selection calculation methods, such as finding asymptotes and assignment method;*
T	*Reasoning strategy*	*Qualitative reasoning, such as image increment and subtraction, limit solution; Or overall description, such as the square of a number is non-negative;*
Y	*Meta policy*	*Do not use written representations, such as changing the formula form*

2.3 Data collection and processing

2.3.1 Data Collection

The researchers distributed the test paper to 380 randomly sampled students and collected 380 questionnaires, of which 376 were valid, with a recovery rate of 100.0% and an effective rate of 98.9%.

2.3.2 Data processing

To answer the first research question, the Pearson correlation coefficient and the single regression analysis of the test scores calculated by using the intelligent classroom were calculated. Based on the teaching process of wisdom class, 80 high school students were selected for cluster analysis, and the types of problem-solving strategies used by the selected students in the function problem test paper were coded according to the types of problem-solving strategies, and the similarities and differences of problem-solving strategy types among the 80 students were compared to answer the second research question.

ISSN 2616-5805 Vol. 4, Issue 5: 16-22, DOI: 10.25236/AJMS.2023.040503

3. Research results and analysis

3.1 Current situation of solving function problems in senior high school students' wisdom classroom

In the first part, the mean value and standard deviation of the test paper for function problems is 3.63, and the standard deviation is 2.784. From the average point of view, the ability of high school students to solve function problems needs to be further improved. The overall difficulty of the test paper is 0.31, and the difficulty tends to be above average. The coefficient is 0.51, 0.49, 0.28, 0.12, 0.52, 0.48, 0.37, 0.16; There were significant differences between high and low groups (t=-76.402, sig=0.00). The following types of questions were classified and the answers were analyzed:

Example 1 Function tangent problem: Given function$b\epsilon R, function f(x) = \ln x + b(1-x), g(x) = e^x$.

(1) monotonicity of discussion;

(2) Make the tangent sum of the curve sum through the origin respectively, and verify that the slopes of the two tangent lines are reciprocal to each other.

According to the requirements of the problem stem, most of the high school students use algebraic method to solve it, and some use special numerical algebra, but it is difficult to find the root; At the same time, most students lack qualitative analysis of function image characteristics, and the answers are incomplete; Therefore, some students use the interactive tools in the wisdom class to answer the number of high school students' equivalent transformation equation roots, use the "mathematical function" to draw graphs, and get the monotonicity of the function.

Example 2 The existence problem of zeros: Give the number of zeros of the function $f(x) = x(x^2+2) - 12$.

In the second question, many students took the non-intelligent classroom method to answer, in which the root of the equation was solved by substituting the special value; Most students use derivative method to study zero points, misunderstand the function problem as constant, resulting in a slightly lower scoring rate. In addition, the teacher gave a question about zero point, and the students used the smart pen to answer it. The smart pen system automatically counted the number of answers and the correct rate, and found that the students had insufficient understanding of the zero point is the horizontal coordinate of the intersection of the function image and the axis. The GGB dynamic software is used to display the quadratic images with two points of intersection with the axis. At the same time, the students' works are collected by the smart pen system. The existence theorem of zero is obtained through comparison and communication.

Example 3 Inequality solving problem: Solve the inequality $\frac{x^2-5}{x^2-8} < 0$

The method of solving quadratic inequalities with one variable is the basic content in middle school mathematics, most students can identify the characteristics of inequalities, and transform them, and combine with the one-dimensional quadratic function image to determine the solution set of inequalities. Most students have no difficulty in converting inequality division equivalence to inequality multiplication, but the students who answer by hand sketching have confusion in solving set and cross relations when classifying the different sign cases discussed. Using the projection function presented by the content of the smart classroom, it shows the use of variance formula to factor decomposition, so that it meets the application requirements of the root method, and shows a solution set less than 0 in the image.

The second part uses the wisdom classroom to solve the function problem. The following survey table analyzes the basic situation of teachers using the wisdom classroom.

In summary, among the functions of content presentation, "editing and writing" is the main interactive tool in the subject of functions. Students' answers are recorded on the electronic whiteboard [8]. 19% of male teachers think the effect is good, while 15% of female teachers think it is bad. Teachers who have taught for less than 5 years are more familiar with the use of wisdom classroom because they have been in contact with wisdom classroom for a long time. However, teachers who have been teaching for more than 16 years have low proficiency in using the projection, editing and writing of the smart classroom, and their ability to operate the smart classroom needs to be improved(see table 5).

ISSN 2616-5805 Vol. 4, Issue 5: 16-22, DOI: 10.25236/AJMS.2023.040503

Table 5 Basic situation of teachers' use of wisdom classroom

specific function		problem setting	question option	gender		teaching duration(years)			
				male	female	<5	[5,16]	>16	P
content presentation	editing writing	proficiency in using function content	beyond-compare	19	12	12	8	4	0.02
	drop-shadow		ordinary	6	17	9	3	2	
			range	8	15	4	1	0	
interaction	sign in	the number of uses of interactive teaching using communication	frequently	3	17	3	8	4	0.17
			unmeant	6	4	12	2	5	
	preemptive answer		never	3	16	5	3	9	
	job-statistics and push	a way of making use of mathematical functions	learn from-colleagues	19	4	11	5	3	0.03
	system-assessment		yourself-made	13	5	4	6	6	
			download-unified	14	8	1	4	7	
			department-production	12	9	2	5	2	
mathematical function	graphing	the degree of adaptability to smart classroom teaching	self-comparison	6	13	4	10	3	0.59
			adaptation	15	16	16	2	10	
			inadaptation	3	17	2	6	4	

19 percent of male teachers copied their colleagues' graphics and 14 percent downloaded them. More than half of the teachers copied their colleagues' content, while only 5 percent of female teachers created their own(see table 5). This shows that a considerable number of teachers use their own "mathematical function" to draw graphs as the main teaching activity, and in this process, students do not realize the real thinking activities of exploration, discussion and induction, and the status quo of "filling the classroom" is still the same.

3.2 Correlation analysis of high school students' ability to solve functional problems with the use of intelligent platform

The correlation analysis was carried out between the test scores of students' functional problems and the test scores of functional issues in the wisdom classroom. The Pearson correlation coefficient was 0.719, and there was a correlation at the level of 0.01. It can be seen that the test scores of function problems are directly proportional to the test scores of function topics in the wisdom class, and it can be concluded that the problem-solving ability of function problems in the wisdom class of high school students is positively correlated with the test scores. On this basis, the prediction result was obtained through the results of unitary regression analysis. The main author took the test scores of 380 high school students in the function topic under the wisdom class as the independent variable (x), and the test scores of their function problems as the dependent variable (y), and conducted unitary linear regression analysis on them. The regression equation obtained was $y = 1.012x + 1.397$, The correlation coefficient was 0.716, the simulation fit was good（$R^2 = 0.497$）, and the significance was 0.00. Therefore, to a certain extent, senior high school students' test results of the function topic in wisdom class are higher than those of hand-drawn drawing function questions.

3.3 Cluster analysis of functional problem solving strategies of senior high school students in smart classroom

The selection of clustering is based on the scores of the function test paper in the wisdom class. As some students have low scores in the test, it is impossible to analyze the solution of the function problem. Therefore, this study selects 80 students with top 70% scores and divides them into 8 groups, which are recorded as B1, B2, B3, B4, C1, C2, C3 and C4.

According to the coding table of problem-solving strategy types, the strategies for solving function problems in the wisdom class of 80 students were coded respectively. Finally, the use frequency of each group was statistically calculated from high to low to get B1 (strategy of element, calculation, inference and identification feature); B2 (calculation, element, inference); B3 (calculation, inference, element, identification feature strategy); B4 (calculation, element, inference, identification feature strategy); C1 (meta, computational, inference strategy); C2 (calculation, element, identification feature strategy); C3 (computational strategy) and C4 (computational, meta-strategy).

ISSN 2616-5805 Vol. 4, Issue 5: 16-22, DOI: 10.25236/AJMS.2023.040503

The results show that 17% of students in group B tend to use reasoning strategies, followed by meta-strategies; At the same time, it is found that the calculation strategy is higher than the feature recognition strategy, mainly for the following reasons: First, in the analysis and understanding of teaching materials, most teachers believe that using smart classroom technology can make students have a comprehensive understanding and grasp of the important and difficult points in teaching; Second, the external reason is that students' enthusiasm for classroom learning is high; In the consideration of students' psychological aspects, such as students' interest, learning motivation, etc.; The internal reason is that students are not skilled in technology, and the use of flexibility is not enough, such as: habitually deformed function expressions, without taking into account intelligent software, subconsciously reducing the difficulty of the test.

59% of the students in group C mainly used computing strategies in the process of solving functional problems, followed by meta-strategies, especially 24% of the students in group C3. The derivative method was used in the whole test paper, but there was a situation that the derivation function was confused with the original function in the process of solving the problem. The image features were drawn by the smart pen system to solve the problem. At the same time, it can be found from the results that this kind of students basically do not use reasoning strategies and feature recognition strategies in the process of problem solving. The reason is that some students cannot accurately know the function image, can not correctly understand the problem and properly represent the problem, resulting in the problem solving strategies are not reflected.

4. Discussion

The sample of the questionnaire is 380 high school students. This paper conducts a preliminary study on the application of wisdom classroom to solve function problems in high school students. The test scores of high school students on function topic in wisdom classroom are higher than those on hand-drawn drawing to answer function questions. At the same time, in the correlation analysis between the test scores of function problems and the test scores of function topics under the wisdom class, the two are positively correlated. The cluster analysis of 80 high school students shows that the students with better test scores are more inclined to the calculation strategy and the reasoning strategy when solving function problems, and the frequency of these two strategies is more similar. In addition, students with average test scores choose more meta-strategies, followed by computational strategies; These students can selectively apply various strategies to find answers according to the difficulty of the questions. In addition, these students have similar strategies to the former; At the same time, students with low test scores used calculation strategy more, and there was almost no reasoning strategy in the whole process. Teachers only use the PPT made to show the whole page, and will not use mind maps, geometric drawing boards, etc.

5. Conclusions

Based on the above research results and discussion, the feedback of the function test paper shows that the function problem-solving ability still needs attention in the wisdom class of high school students. In order to improve the ability of high school students in N City and A county to solve function problems under the wisdom class, the following suggestions are made:

First, smart classroom teaching should start from attracting students' attention, pay attention to the dynamic changes of students' feedback, participation attitude and participation effect in class, and constantly adjust teaching methods to achieve the best teaching effect. In the teaching process, the teacher draws the sketch of the elementary function according to the "three-step method" of the image, so that the students can master the characteristics of the image, and cultivate the students' consciousness of associating the function problem with the image problem, so as to improve the function's problem-solving ability and intuitive imagination ability.

Second, teachers should rationalize the use of smart classroom technology, at the same time pay attention to the use of teaching methods, master the skills of making PPT courseware, simple production of audio and video methods and some operating software. When understanding the nature of the function, the intelligent platform dynamic software is used to draw the image, which can use the image to visualize the function problem and weaken the abstract degree of the function problem, so that students can efficiently construct the basic nature of the function and learn effectively.

Third, when explaining the test questions, the teacher can send the exercises to the students through

ISSN 2616-5805 Vol. 4, Issue 5: 16-22, DOI: 10.25236/AJMS.2023.040503

the wisdom platform, and conduct "pre-test", so that the students can judge which belong to the function, how the increase and decrease is, and deeply understand the monotonicity of the function and the analytic expression of the corresponding relationship; The intelligent platform is used to analyze the viewing degree of students' micro-lessons and the completion effect of exercises, and to encourage students to self-diagnose, so as to reserve knowledge to a higher degree and establish a systematic knowledge network.

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