

# Research on Optimization Strategies of High School Mathematics Classroom Teaching Based on Teaching Behavior Analysis

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## Abstract

This study takes the high school mathematics classroom as the research object. By systematically analyzing the problems of teachers' teaching behaviors, it explores the classroom teaching optimization strategies based on the analysis of teaching behaviors. Research has found that current high school mathematics classrooms have problems such as monotonous teaching behaviors, insufficient interaction between teachers and students, and a lack of hierarchical problem design. In response to these problems, optimization strategies such as optimizing teaching behavior design, strengthening classroom interaction mechanisms, improving problem-driven strategies, and innovating teaching evaluation methods have been proposed. Research shows that through scientific analysis and optimization of teaching behaviors, the quality of high school mathematics classroom teaching can be effectively improved, and the development of students' core mathematical literacy can be promoted.

## Keywords

Teaching behavior analysis; High school mathematics; Classroom teaching; Optimization strategy

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## 1. Introduction

Classroom teaching is the core link of educational activities. Teachers' teaching behaviors directly affect teaching effectiveness and students' development. As an important subject for cultivating students' logical thinking and problem-solving abilities, the improvement of classroom teaching quality in high school mathematics has always been a focus of educational research. With the in-depth advancement of the new curriculum reform, higher requirements have been put forward for high

school mathematics classroom teaching. It is not only necessary to impart knowledge but also to cultivate students' core mathematical literacy.

## 2. The basic connotation of teaching behavior

Teaching behavior is the sum total of all kinds of teaching activities carried out by teachers in a specific teaching situation to achieve teaching goals. In high

school mathematics classrooms, teaching behaviors mainly include lecturing behavior, questioning behavior, demonstrating behavior, guiding behavior, and evaluating behavior etc. These behaviors are interrelated and together form a complete teaching process.

### 3. The main problems existing in teaching behaviors

There are some aspects in the current teaching behaviors of high school mathematics classes that are worth reflecting on. Teachers habitually adopt the method of full-class lecturing in the classroom. From definitions to formulas and then to example problems, they basically explain everything themselves. Students merely listen passively and take notes, rarely having the opportunity to explore or discuss and exchange ideas by themselves<sup>[1]</sup>. The interaction between teachers and students seems frequent, but the questions raised by teachers mostly remain at the superficial level of right and wrong. Students can answer without in-depth thinking. The classroom appears lively on the surface, but actually lacks the content of thinking. Teachers seldom take into account the differences among students when preparing lessons and teaching. One set of teaching plans and one progress schedule applies to all students in the class. Students with weak foundations cannot keep up, and those with spare capacity cannot improve. In class, teachers often only find out whether students have understood or not, and whether they have done the exercises correctly when grading homework or taking exams. This misses the best opportunity to correct mistakes, and problems accumulate later on, making them even more difficult to solve.

## 4. Optimization strategies for high school mathematics classroom teaching

### 4.1. Optimizing the design of teaching behaviors and building diversified classrooms

When designing teaching behaviors, teachers should not adopt a one-size-fits-all approach but adjust the combination of behaviors based on the specific characteristics of the class type (Table 1). When teachers are teaching new knowledge such as the concept of functions, they can start with real-life examples as the entry point. For instance, they can introduce piecewise functions by using the tiered pricing of water fees, allowing students to explore the patterns in specific problems. Then, students can try to summarize the essential characteristics of the concept by themselves. Finally, the teacher can guide everyone to transfer this concept to other mathematical contexts. Such a design is much more vivid than directly throwing out the definition. When dealing with exercises, teachers can adopt a different approach<sup>[2]</sup>. For instance, they can directly project typical mistakes made by students in their homework onto the screen, allowing everyone to collectively think about where the mistake occurred and why it happened. Then, the teacher can guide students to sort out the correct problem-solving path. Finally, they can provide two or three variant questions for students to practice on the spot.

Teachers should also pay attention to controlling the pace of the class. If they talk too much, students' thinking may become confused. If the activities are too scattered, they may fail to grasp the key points. From actual observation, it is best that a teacher's explanation in a class should not exceed 25 minutes, and at least 15 minutes should be left for students to do things by themselves and think independently. When students are

**Table 1.** Reference for teaching behavior design of different lesson types

Course type	Core behavior sequence	Suggestions for time allocation
Concept class	Context introduction → Exploration and discovery → Abstract construction → Application consolidation	5 minutes for introduction, 15 minutes for exploration, 10 minutes for construction, and 15 minutes for application
Exercise class	Error case analysis → Method refinement → Variant training → Summary and reflection	Analysis takes 12 minutes, refinement 8 minutes, training 20 minutes, and summary 5 minutes
Review class	Knowledge connection → Thematic breakthrough → Comprehensive application → Filling in the gaps	Connect for 10 minutes, breakthrough for 15 minutes, apply for 15 minutes, and fill in 5 gaps

practicing, teachers can patrol and observe and provide individual guidance. This can help identify problems in a timely manner and make adjustments to subsequent teaching. The design of teaching behaviors should be adapted to local conditions. Teachers should not only have a basic sense of framework but also maintain the space for flexible adjustment. Only in this way can each class be novel and effective.

#### **4.2. Strengthening the classroom interaction mechanism and enhancing students' participation**

The quality of classroom interaction often depends on the level of question design. When preparing lessons, teachers need to break away from the stereotype of closed-ended questions like "Is it right or wrong?" and instead design a chain of questions that can trigger cognitive conflicts among students. For instance, teachers can first present a description of a phenomenon, then ask why this situation occurred, and further inquire what would have happened if the conditions had changed at that time. Such progressive questioning can truly activate students' thinking. The openness of the questions should be well-balanced. If they are too broad, students won't know where to start; if they are too narrow, the value of discussion will be lost. The ideal situation is for the majority of students to have something to say, but not too much. The singularity of interactive forms is a pain point in current classrooms. While teacher-led question-and-answer sessions are important, communication among students often generates more sparks. Group discussions should not just be a formality. Teachers should give students sufficient time to truly explain the problems thoroughly. The peer review session is often overlooked. In fact, while students are evaluating others' homework or viewpoints, their own understanding is also deepening. Sometimes, when students step onto the podium and explain the knowledge points to their classmates in their own words, the learning effect brought about by this role transformation often exceeds expectations. The creation of a classroom atmosphere requires continuous attention. Whether students dare to speak and are willing to speak largely depends on the teacher's attitude in daily life. Teachers should sincerely accept students' mistakes and doubts, turning a wrong question into a good one and

taking a wrong answer as providing a new perspective. This is not about blind accommodation, but rather, while protecting students' desire to express themselves, guiding them towards the right path in a more ingenious way. Over time, students find that the classroom is a safe place where their questions won't be criticized and their expressions won't be ridiculed. Naturally, they are willing to speak up more <sup>[3]</sup>.

#### **4.3. Improving problem-driven strategies and cultivating mathematical thinking**

The design level of mathematical problems directly affects the depth of students' thinking. When preparing a function class, teachers should not merely focus on formulaic exercises like finding the domain of this function, but rather find ways to truly stimulate students' thinking nerves through the problems. For instance, when teaching quadratic functions, teachers can first present several different parabolic graphs and ask students to observe the patterns among the opening directions, symmetry axes, and vertex coordinates of these curves. Such questions will draw students' attention to the essential connections. The difficulty of the problem should be set at a level that is easily accessible to students. This moderate cognitive conflict can most effectively stimulate the desire to explore. The way a problem is presented often captures students' attention more effectively than the problem itself. When teachers place math problems in real-life scenarios, students' interest can be immediately enhanced. When teaching the summation of sequences, instead of directly presenting the formula, teachers should first tell a small story about Gaussian summation and then ask if there are any ingenious methods if there are more and more complex numbers. In this way, students will actively explore the value of the general term formula. Task-oriented problems are also particularly useful. For instance, when students are asked to design a function model to describe the relationship between express delivery costs and weight, they will naturally understand the concept of piecewise functions thoroughly during the process of completing the task. Comparative problems can enable students to see the multifaceted nature of mathematics. Teachers can present two problem-solving approaches simultaneously, allowing students to compare which one is more concise and why they thought of using

this method. This comparison will prompt students to reflect on their own thinking paths. The design of open-ended questions requires teachers to break free from the constraints of standard answers. After teaching solid geometry, teachers can ask what interesting questions they can raise using the knowledge learned today. This kind of open-ended questioning can enable students with spare capacity to showcase their creativity. Some questions are deliberately left unfinished, and the answers are not unique or need to be discussed in categories. In the process of exploring multiple possibilities, students' flexibility in thinking will gradually be cultivated.

#### **4.4. Implementing stratified teaching behaviors and paying attention to individual differences**

The key to stratified teaching lies in whether teachers can truly see the starting point of each student. At the beginning of the term, teachers should figure out the mathematical foundation of the students in the class, not simply label them as excellent, average, or poor, but understand which knowledge points they are stuck on and which types of questions they are prone to make mistakes in. When teaching trigonometric functions, teachers should be clear in their minds that some students may not even understand the induction formula, while others can already flexibly apply the difference and product. At this time, the teaching objective should not be one-size-fits-all. Teachers can set goals for students with weak foundations to master basic formulas and be able to apply them, for average students to be able to flexibly select formulas in variant problems, and for students with spare capacity to try to explore the intrinsic connections between formulas. In this way, students at every level have a direction to strive for and will not feel that the goal is out of reach or too unchallenging. In addition, when teachers assign consolidation exercises after the example questions, they can prepare three levels of questions, marking the basic questions, advanced questions, and challenge questions on the projection, and let students choose to do them according to their own situations. Basic questions ensure the direct application of core knowledge points, advanced questions incorporate some comprehensive operations, and challenge questions require a twist to come up with solutions. Students feel a sense of achievement after completing the basic questions

and are willing to try the advanced ones. Students who have completed the advanced questions will be attracted by the challenging ones. This kind of autonomous choice is much more effective than teachers forcing questions into them. The grouping strategy in group cooperation is also very important. Heterogeneous grouping can enable students of different levels to encourage each other. Students with a good foundation deepen their understanding in the process of explaining problems to their peers, while students with a weak foundation often find it easier to accept explanations from their peers than from teachers. Teachers should observe the status of group discussions and can flexibly adjust the division of labor within the group to ensure that each person has a specific task. After-school tutoring should be even more precise. Teachers cannot say the same thing to everyone. When facing students who always make mistakes in calculations, teachers should keep an eye on their calculation steps to find loopholes. When students find it hard to think freely, teachers should guide them to draw diagrams and set up formulas, and look at problems from a different perspective<sup>[4]</sup>.

#### **4.5. Innovating teaching evaluation methods and improving feedback mechanisms**

The timing of evaluation is often more important than the content of the evaluation. Teachers should develop the habit of catching students' learning signals at any time in the classroom. When students frown while doing exercises, remain silent during discussions, or hesitate when answering questions, these micro-expressions and small actions are all conveying information. When a teacher notices a student getting stuck during the derivation process, they should not wait until the class is over to discuss it. Instead, they should walk over to the student's scratch paper on the spot, point out what the basis for this transformation is, and why the symbol has changed. This immediate feedback can prevent wrong ideas from solidifying. After asking questions in class, teachers should not rush to announce the answers. Instead, they can first let a few students share their thoughts. From their responses, it can be determined which knowledge points have not been fully grasped, and the subsequent explanations will be more targeted. The accuracy of the evaluation language directly affects the speed of

students' progress. When teachers grade homework, they should avoid giving vague comments that leave students confused about their strengths and where they should improve after reading. Teachers should write specific comments. For instance, for this problem, your approach using the method of undetermined coefficients is correct, but you missed considering one situation when setting parameters. It is suggested that all possibilities be listed in a table for investigation. With such feedback, students will know how to improve when they receive it. The same goes for oral evaluation. When teachers praise students, they should clearly state that their solution saves two steps compared to the conventional method, indicating that they have a thorough understanding of the essence of the formula, rather than simply saying it is good. When pointing out problems, the tone should be gentle but the attitude firm, so that students understand that this mistake cannot be dealt with ambiguously. The process of students' participation in the evaluation itself is a form of deep learning. After the teacher finishes explaining the example questions, they can ask students to rate their classroom exercises against the marking criteria. During the comparison process, students will discover where they lost marks and will pay special attention next time. Mutual marking among deskmates can better cultivate critical thinking. Students often check others' test papers more carefully than they correct their own. Discovering others' mistakes is also equivalent to giving themselves a reminder. Teachers should teach students how to evaluate in a constructive way. They should not just say that you are wrong. Here, it should be simplified first and then substituted. Directly substituting involves too much calculation. The mutual evaluation session after the group presentation was also particularly valuable. The students in the audience evaluated the problem-solving approaches on the stage, which not only exercised their expression skills but also deepened their understanding of the knowledge.

#### **4.6. Integrating information technology and innovating teaching behaviors**

The value of information technology lies in its ability to make abstract mathematical concepts tangible and touchable. When teachers explain the transformation of function graphs, if they only draw a few static curves

on the blackboard, students will find it difficult to understand the impact of parameter changes on the graph. However, it is completely different when demonstrated with the GeoGebra software. When the teacher drags the parameter slider, students can directly observe how the parabola moves up and down, left and right, and the opening becomes larger and smaller. Such a dynamic process cannot be drawn on paper. When teaching solid geometry, technical assistance is even more necessary. Students with weak spatial imagination simply cannot establish a sense of three-dimensionality when facing planar figures. Teachers can use 3D modeling software to rotate geometric bodies and display them from different angles. Students will immediately understand the positional relationship between points, lines, and surfaces. The application of online platforms can enable teaching to break through the time and space limitations of the classroom. Teachers can upload micro-lesson videos and preview tasks to the platform in advance. Students can go through the basic knowledge at home first and come to class with questions, thus freeing up class time for more in-depth discussions. During the interactive session in class, students can answer questions using an answerer or their mobile phones. The answers of all the students in the class can be instantly summarized into a chart, and the teacher can immediately see which option has been chosen by the most people and where the error rate is concentrated. After-class homework is submitted through the platform, and the system automatically grades objective questions. Teachers only need to focus on marking subjective questions and providing individual tutoring, which greatly reduces their workload. The data generated by technology can provide a basis for teaching decisions. When teachers retrieve students' problem-solving records from the platform's backend, they will find that some students always get stuck on a certain type of question, and some students solve problems very slowly. Based on the data analysis, teachers can know what to focus on in the next class and which students need individual tutoring.

## **5. Conclusion**

Through an in-depth analysis of high school mathematics classroom teaching behaviors, this study has revealed

the main existing problems and proposed targeted optimization strategies. Practice has shown that by optimizing the design of teaching behaviors, strengthening classroom interaction, improving problem-driven approaches, implementing stratified teaching, innovating evaluation methods, and integrating information technology, the quality of high school mathematics classroom teaching can be effectively improved, and the

development of students' core mathematical literacy can be promoted. Future research can further focus on the optimization of teaching behaviors for different teaching contents and student groups, develop more precise teaching behavior analysis tools, and provide stronger support for the reform of high school mathematics teaching.

### Disclosure statement

The author declares no conflict of interest.

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