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Research on Cultivation Strategies of Mathematics Application Ability for Ninth-Grade Students

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Abstract: *Mathematics application ability is an important component of the core mathematics literacy of ninth-grade students, which directly affects students' in-depth understanding of mathematical knowledge and their ability to solve practical problems. Based on the actual situation of ninth-grade mathematics teaching, this paper analyzes the existing problems in the cultivation of students' mathematics application ability, and puts forward specific cultivation strategies from four dimensions: optimization of teaching content, innovation of teaching methods, expansion of practical activities, and improvement of evaluation system. It aims to improve ninth-grade students' ability to analyze and solve practical problems by using mathematical knowledge, and provide a reference for the reform of junior high school mathematics teaching.*

Keywords: *ninth-grade mathematics; application ability; cultivation strategy*

1. Introduction

As a basic subject, the value of mathematics lies not only in the teaching of theoretical knowledge, but also in its application to real life and solving practical problems. As a key transition period in junior high school, ninth-grade students face the pressure of the senior high school entrance examination. Mathematics teaching often focuses more on the training of problem-solving skills and memorization of theoretical knowledge, ignoring the cultivation of application ability. This leads to the problem that students "understand theories but are difficult to apply", making it hard for them to adapt to the social demand for interdisciplinary talents. Therefore, exploring scientific and effective strategies for cultivating mathematics application ability of ninth-grade students has become an important topic in junior high school mathematics teaching[1].

2. Existing Problems in Cultivating Ninth-Grade Students' Mathematics Application Ability

2.1 Teaching Content is Divorced from Reality

At present, the teaching content of ninth-grade mathematics mostly revolves around textbook knowledge points and examination points for the senior high school entrance examination, which is dominated by abstract formulas and theorem derivations, lacking connection with students' real life. For example, the teaching of quadratic equations with one unknown only focuses on formula solving, without combining practical scenarios such as profit calculation and project planning; function teaching lacks relevance to real problems such as economic growth and resource allocation. As a result, students are difficult to perceive the practical value of mathematics, and their learning enthusiasm and application awareness are weak.

2.2 Single and Solidified Teaching Methods

The traditional teaching mode of "teacher lecturing and students listening" is still dominant in teaching. Classroom interaction is mostly limited to exercise explanation and answer checking, lacking guidance for students' application thinking. Teachers rarely organize activities such as group discussion, case analysis and situational inquiry. Students passively accept knowledge and lack opportunities to actively use mathematical knowledge to analyze problems and construct mathematical models, so their application ability is difficult to improve in practice.

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2.3 Lack of Systematic Practical Activities

Extracurricular practical activities are an important carrier for cultivating mathematics application ability, but the current mathematics practical activities for ninth-grade students are fragmented and formalized. Some teachers only arrange simple practical tasks at the end of chapters, lacking in-depth integration with teaching content; practical themes are single, mostly focusing on basic fields such as measurement and statistics, not involving complex application scenarios such as engineering, finance and decision-making, so students are difficult to comprehensively exercise their comprehensive application ability.

2.4 Evaluation System Focuses on Results

The evaluation of mathematics application ability mostly depends on written examination results, and the evaluation content mainly focuses on theoretical knowledge memorization and problem-solving proficiency, lacking attention to students' application process. For example, application problems in written examinations only examine the application of single knowledge points, ignoring the assessment of students' logical analysis, model construction, scheme optimization and other abilities; there is a lack of diversified evaluation methods such as daily performance evaluation and practical achievement evaluation, which cannot fully reflect students' application ability level and effectively guide teaching to tilt towards the cultivation of application ability[2].

3. Strategies for Cultivating Mathematical Application Ability of Ninth-Grade Students Oriented by Core Competencies

3.1 Optimizing Teaching Content: Reconstructing the Knowledge System and Strengthening Life and Social Connections

Teaching content is the carrier of ability cultivation. Only by transforming mathematical knowledge from the abstract to the concrete, from textbooks to real life, and from examination points to practical problems can we truly awaken students' awareness of application and help them understand the practical value of mathematics.

3.1.1 Deeply Exploring Life Materials to Visualize Abstract Knowledge

Closely combining the key knowledge points of ninth-grade mathematics, we systematically collect life materials that are visible, perceptible, and accessible to students, embed abstract formulas, theorems and properties into real scenarios, and enable students to understand the origin and application direction of knowledge in familiar situations.

In the teaching of inverse proportional functions, cases such as "the relationship between speed and time with a fixed distance", "the relationship between unit price and sales volume with a fixed total commodity price", and "the relationship between floor tile side length and quantity with a fixed classroom area" are introduced to help students explain life phenomena with functions. In the teaching of geometric figures, combined with scenarios such as house decoration, bridge structure, packaging design, basketball shooting trajectory and camera monitoring range, we explain the practical uses of triangle stability, circle symmetry, Pythagorean theorem, similar triangles and solving right triangles. In the teaching of statistics and probability, cases such as lottery winning, game fairness, weather forecast precipitation probability and class performance analysis are used to help students feel the connection between statistics and decision-making.

Through the regular integration of life materials, we break students' sense of distance from mathematics, make them realize that mathematics is everywhere, usable and practical, and stimulate their willingness to apply at the root.

3.1.2 Closely Following Social Hot Issues to Improve the Modernity and Applicability of Teaching

Focusing on social development, scientific and technological progress and people's livelihood issues, we transform contemporary issues into mathematical problems, enable students to improve their application ability by solving real social problems, and enhance their sense of social responsibility.

In statistics teaching, we integrate real data such as waste classification data, community population structure, urban traffic flow and new energy vehicle ownership. In the teaching of equations and inequalities, we combine problems such as agricultural product sales, rural revitalization budgets,

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campus fund allocation and epidemic prevention and control material allocation. In the teaching of function maximum and minimum values, we introduce decision-making problems such as enterprise cost control, express route optimization and photovoltaic power station revenue calculation. The deep integration of social issues and high school entrance examination points not only conforms to the proposition trend but also enables students to experience the important role of mathematics in social governance, economic development and ecological protection.

3.1.3 Breaking down Chapter Barriers in Textbooks to Build a Modular Applied Knowledge System

Centering on "application ability", we carry out cross-chapter integration of ninth-grade knowledge such as number and algebra, graphics and geometry, statistics and probability, functions and equations to form thematic, project-based and task-based knowledge modules, and improve the comprehensiveness and applicability of knowledge.

For example, by integrating linear functions, quadratic functions, statistics and inequalities, we design a comprehensive project "Campus Supermarket Operation Optimization". Students investigate commodity sales volume, pricing and cost, establish a profit function model, analyze the optimal pricing, predict sales trends and put forward inventory and promotion plans. By integrating solving right triangles, similar triangles, Pythagorean theorem and measurement knowledge, we design a thematic module "Campus Surveying Engineer" to complete measurement tasks such as flagpole height, teaching building width, playground area and street lamp irradiation range. By integrating statistics, probability and data processing knowledge, we design a project "Campus Safety Risk Assessment" to make statements and decisions with data[3].

Through modular integration, students no longer memorize knowledge points in isolation, but learn to comprehensively use knowledge in multiple fields to solve complex problems and meet the requirements of comprehensive questions in the high school entrance examination.

3.2 Innovating Teaching Methods: Transforming the Teaching Mode and Activating Active Application Thinking

Teaching methods determine the depth of students' participation and the height of their thinking. We must shift from "teachers teach and students listen" to students' active exploration, cooperative construction and application output, so that students truly become the masters of learning.

3.2.1 Situational Teaching Method: From Knowledge Transmission to Problem-Driven Learning

Based on the cognitive level of ninth-grade students, we create real, interesting and moderately challenging problem situations to guide students to actively construct knowledge and form model concepts in the process of solving problems.

In the teaching of "Application of Similar Triangles", we create a series of situations of "measuring the height of ancient trees, flagpoles and street lamps on campus". Instead of directly giving methods, we first let students think about "how to use mathematics to solve the height that cannot be directly measured". Students independently put forward the shadow method, benchmark method and mirror reflection method, then design plans in groups, conduct on-the-spot measurements, calculate and verify, and analyze errors, completely experiencing the process of "real problem → mathematical abstraction → model construction → solution and verification". In the teaching of "Maximum and Minimum Values of Quadratic Functions", we create decision-making situations such as "minimizing materials for rectangular fences", "maximizing profit from commodity pricing" and "optimizing the cross-sectional area of water channels", allowing students to independently establish function models, analyze image properties and find optimal solutions.

The core of situational teaching is to drive thinking with problems and guide exploration with tasks, enabling students to understand and apply mathematics in "doing mathematics".

3.2.2 Group Cooperative Learning Method: From Individual Learning to Collaborative Inquiry

Taking real application tasks as the carrier, we design group cooperative learning with clear division of labor, clear responsibilities and mutual assistance, so that students can improve their application ability and communication and collaboration literacy in coordination.

A typical task is "Investigation of Community Residents' Travel Modes". The group is divided into data collectors, data organizers, chart drawers, conclusion analysts and report writers, who respectively complete questionnaire design, resident interviews, data entry, chart production, feature analysis and

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traffic optimization suggestions, and finally form a complete investigation report. In the process of cooperation, students must communicate in mathematical language, support viewpoints with data and perfect plans with logic, which not only consolidates knowledge such as statistics and charts but also improves their ability to express, collaborate and solve real problems.

Group cooperation allows every student to participate in the whole application process, makes up for the limitations of individual learning, and cultivates the teamwork ability required for future society.

3.3 Expanding Practical Activities: Building a Three-Stage Practical System to Deepen the Connection between Theory and Practice

Practice is the key to the implementation of application ability. We build a systematic three-in-one practical platform of in-class mini-practice, after-school thematic practice and achievement display practice, enabling students to learn in "doing, applying and creating".

3.3.1 In-Class Mini-Practice: Instant Application to Strengthen Application Awareness

Using the last 5–10 minutes of class, we design short, small, fast and practical mini-practice tasks to achieve "practice immediately after learning, apply immediately after learning" and eliminate the "disconnection between learning and application".

Upon completing the unit on right triangles, students measure the height of classroom windows, the tilt angle of desks, and the width of blackboards. After learning probability theory, students conduct ball-drawing experiments, analyze the fairness of dice, and verify the probability of lottery draws. Upon finishing the statistics module, students perform quick statistical analysis and draw corresponding charts based on group data of height, eyesight, and academic performance.

Mini-practice is simple to operate, time-saving and direct in effect, allowing students to immediately feel the use of knowledge and continuously strengthen their application awareness.

3.3.2 After-School Thematic Practice: Systematic Improvement to Cultivate Modeling Ability

Combined with teaching progress and seasonal characteristics, we carry out one thematic after-school practice per month, divided into three types: social investigation, mathematical modeling and decision optimization.

Social investigation: statistical analysis of household income and expenditure, modeling of local temperature change trend, evaluation of campus waste classification efficiency and investigation of students' pocket money use. Mathematical modeling: optimal scheme for shared bicycle placement, campus parking space layout design, canteen window quantity optimization and campus green area measurement. Decision optimization: sports meeting schedule arrangement, class activity budget and book corner book allocation plan.

After-school practice allows students to step out of the classroom into life, completely experience the process of data collection → sorting → analysis → modeling → decision-making → suggestion, and systematically improve their mathematical modeling and comprehensive application ability.

3.3.3 Achievement Display Platform: Externalization of Value to Stimulate Sustainable Motivation

We build a multi-level achievement display platform to make students' application achievements seen, recognized and communicated, stimulating their internal learning motivation.

School level: hold mathematics application achievement exhibitions, mathematical modeling competitions and optimal scheme design contests. Class level: set up practice report walls, group defenses and model explanation sharing. Evaluation level: include excellent achievements in comprehensive quality evaluation, recommend campus publicity, and submit feasible schemes to the school for adoption. When students see their measurement data, investigation reports and optimization suggestions being used, they will truly realize that "mathematics is useful and can change life", forming a positive cycle of continuous learning and application.

3.4 Improving the Evaluation System: Building a Diversified Evaluation Mechanism to Guide Competency-Oriented Teaching

Evaluation is the "command stick" of teaching. Only by establishing an evaluation system with diversified content, varied methods, multiple subjects and process-oriented focus can we truly guide teaching towards application and core competencies.

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3.4.1 Diversified Evaluation Content: From Result-Oriented to Process-Oriented

We expand evaluation from "single score" to all dimensions of application ability, including: initiative in knowledge application, situational analysis ability, rationality of model construction, calculation accuracy, logical expression ability, scheme innovation, practical participation and teamwork ability.

A process-based scoring standard is adopted in application problems: situational analysis accounts for 30%, model establishment 40%, calculation result 20% and conclusion interpretation 10%. Even if the result is wrong, students can still get high scores as long as their thinking is correct and the model is reasonable, guiding students to focus on "how to think" rather than "only looking at the answer". In practice evaluation, we focus on assessing scheme integrity, data authenticity, model applicability, report standardization and innovative highlights.

3.4.2 Diversified Evaluation Methods: From Summative Evaluation to Whole-Process Evaluation

We integrate formative and summative evaluation to fully record the development track of students' application ability.

Formative evaluation: classroom observation records, practice manuals, homework analysis, group peer evaluation, project logs and modeling drafts. Summative evaluation: written tests (increasing the proportion of comprehensive situational questions, open questions and modeling questions), practical achievement defense and project report evaluation. Digital tools are introduced: error-correction book systems analyze weak application points, project management platforms track exploration processes, and data tables record practical performance, making evaluation more accurate and objective.

3.4.3 Diversified Evaluation Subjects: From Single Teacher Evaluation to Multi-Subject Collaborative Evaluation

We build a four-in-one evaluation mechanism of teacher evaluation, student self-evaluation, peer evaluation and parental evaluation to make evaluation more comprehensive and authentic.

Student self-evaluation: reflect on deficiencies in situational analysis, model selection and cooperation performance to improve metacognitive ability. Peer evaluation: evaluate contribution, participation, innovation and collaboration attitude to promote mutual learning. Parental evaluation: feedback on students' performance in family practice (income and expenditure statistics, measurement activities) to promote home-school collaborative education. Multi-subject evaluation avoids single-view bias, strengthens students' subjective consciousness and forms educational synergy.

3.4.4 Strengthening Evaluation Feedback: Realizing the Closed Loop of "Evaluation – Feedback – Improvement – Promotion"

We establish a timely, specific and operable evaluation feedback mechanism. Teachers put forward personalized improvement suggestions for students' weak links in situational analysis, model construction, data processing and scheme optimization, and adjust teaching strategies accordingly: for example, increase modeling special training for weak model construction; optimize guidance processes for non-standard practice; strengthen life situation introduction for insufficient application awareness. We promote teaching and learning through evaluation, realize improvement through evaluation, and form a virtuous cycle[4].

4. Conclusion and Prospect

Cultivating the mathematical application ability of ninth-grade students is a systematic, long-term and practical educational project. Its core lies in returning to the essence of mathematics education: making mathematics serve life, problems and development. Faced with the current problems in teaching such as disconnection from life, single methods, fragmented practice and result-oriented evaluation, teachers must change their teaching concepts, break the shackles of examination-oriented thinking, and make collaborative and systematic efforts from four dimensions: teaching content, teaching methods, practical activities and evaluation system.

Through the life-oriented reconstruction of teaching content, students perceive the application value of mathematics and stimulate internal learning motivation. Through the innovative transformation of teaching methods, students shift from passive acceptance to active exploration and truly become masters of learning. Through the systematic construction of practical activities, students deepen their application experience in real operations and improve their modeling and comprehensive

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problem-solving abilities. Through the whole-process empowerment of the evaluation mechanism, we provide direction guidance and institutional guarantee for the cultivation of application ability, and realize the fundamental transformation from “score-oriented” to “competency-oriented”.

In future teaching practice, teachers should continuously pay attention to the reform trend of high school entrance examination propositions and the latest requirements of curriculum standards, combine the actual situation of students, campus resources and local characteristics, constantly optimize strategies, enrich cases and innovate paths, so as to make the cultivation of mathematical application ability more targeted, effective and operable. The ultimate goal is not only to improve students’ examination scores but also to help them form stable competencies of observing with mathematical vision, analyzing with mathematical thinking and solving with mathematical methods, laying a solid mathematical foundation for their senior high school study, lifelong learning and future social development.

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