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Applications of Cognitive Psychology to Mathematics Education

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Abstract:

In the context of the reform of mathematics curriculum teaching in middle schools, how to continuously improve the quality of mathematics classroom teaching has become an important issue. Combining the relevant theories of cognitive structure in mathematical educational psychology and the practical experience in the teaching process, this paper explores how to optimize teaching strategies under the support of educational psychology theory from three aspects: cognitive connection, mathematical understanding and emotional factors, and truly realize the mathematics quality education about the human subject.

Keywords: *Psychology, Mathematics education, Middle school, reform in education.*

I. INTRODUCTION

Educational psychology is an interdisciplinary field between the research practice of mathematics teaching, pedagogy and psychology theory, aiming at building a brand-new theoretical framework of subject education, thus promoting the reform and innovation of teacher education and effectively improving the teaching quality of mathematics education.

China's middle school mathematics education reform has entered a new era of comprehensive depth, connotative development and comprehensive optimization. At the same time, under the core concept of the new curriculum reform, keeping the forefront of middle school mathematics education and teaching and continuously improving the quality of middle school mathematics teaching have become the top priority for every math teacher [1]. How to realize the effective transmission of mathematical knowledge under the guidance of educational psychology theory? How to carry out effective "student-centered" teaching activities around mathematical literacy? How to help students overcome their fear of difficulties in mathematics learning, improve their interest in learning and make the classroom more effective? This paper mainly focuses on the cognitive structure in mathematics education psychology, the psychological essence of mathematics understanding and the emotional factors in mathematics education, and discusses the problems of improving the quality of middle school mathematics teaching and optimizing the teaching design based on my teaching practice experience.

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II. MATHEMATICAL COGNITIVE STRUCTURE

The research results of modern cognitive psychology show that the process of students learning mathematics is actually a cognitive structured process [2-3]. In this process, teachers help students transform their mathematical knowledge into their own mathematical cognitive structure through external media such as writing, language or physical model, which is a process in which internal and external interactions constantly break and rebuild the balance. The good construction of mathematical cognitive structure not only contributes to the storage and operation of information, but also has the function of promoting understanding.

2.1 The Form of Mathematical Cognitive Structure

Mathematical cognitive structure can be regarded as a complex structure composed of nodes and connections. Among them, the node is the object of cognitive structure, and the psychological representation forms such as mathematical concepts and properties are psychological representations, while the connection line is the connection between internal representations. The connection line in cognitive structure is the entrance of cognitive understanding, the clue of recalling knowledge, and the "pointer" to indicate the "address" of the node. The more lines on a node, the more it is connected with more nodes, and the more paths into this node. This cognitive structure refers to the "micro" conceptual structure or the "macro" pointer relationship structure. It is like a dynamic and balanced thinking map, and their interrelationships anchor the relative positions of concepts, properties or their chunks.

In mathematics teaching, we should guide students to pay attention to establishing and enriching the "connection line" between nodes, and learn by distinguishing the differences and similarities of knowledge points. For example, in the teaching of plane geometry, we can design teaching according to the classification methods of straight line, triangle and parallelogram; In the teaching of functions, we can design the teaching according to the classification methods of primary function, quadratic function, exponential function and logarithmic function. In a word, our aim is to guide students to build richer "online" on the basis of conceptual representation, and never instill mathematical knowledge in isolation.

2.2 Subjective Differences of Students' Cognitive Structure

Mathematical cognitive structure is gradually formed and developed by students in their acquired mathematical learning activities. Because different subjects have different understanding and organization of knowledge content and different "preparatory knowledge" stored by students in long-term memory, there are individual differences in mathematical cognitive structure. In the situation of mathematics classroom teaching, external stimuli from books and teachers' lectures first enter the working memory platform before entering the long-term memory [4]. In view of the limited capacity of working memory, students can only be present "selectively". First of all, mathematics teachers should adjust their

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psychological expectations, and it is impossible for every student to "learn the whole lesson and listen to the whole thing" in class. We should pay attention to enriching the connection channels between mathematics knowledge points, not simply dividing each teaching unit, but paying attention to new teaching methods. Secondly, because the knowledge acquired by students is a kind of knowledge that will probably be forgotten if there is no perfect structure to connect it together. Therefore, teachers should realize that effective teaching is to help students realize structured knowledge rather than memorize knowledge content, and optimize teaching strategies according to the principle of "block expansion" of working memory.

III. MATHEMATICAL UNDERSTANDING

In the psychological sense, the mastery of mathematics lies in understanding, and understanding is for the transfer of mathematical knowledge. We can measure the mastery of mathematical knowledge by quantitative means such as test scores, but the more important measure should be the qualitative aspect-whether the learned knowledge has been internalized at the cognitive level, that is, whether the assimilation and adaptation of knowledge have been completed. In the research of psychology, understanding can be divided into several levels, such as understanding, understanding, mastering, skilled application, etc. The purpose of this stratification is to quantify the higher-order meaning-scientifically quantify the concept at the level of psychological measurement. In this paper, we mainly focus on the basic internal psychological mechanism of mathematical understanding.

3.1 Mathematical Understanding Needs Psychological Cognitive Foundation

Ausubel, an educational psychologist, put forward the idea of "meaningful learning" for the first time. He believes that students have the intention of meaningful learning. Compared with mechanical learning, meaningful learning refers to the interaction between the new knowledge represented by symbols and the existing old knowledge in learners' cognitive structure, so that the cognitive structure can be reconstructed. Therefore, new knowledge acquires psychological significance. In the teaching and learning of middle school mathematics, the cognitive foundation is very important. For example, the teaching of solid geometry needs the knowledge foundation of plane geometry, and the construction of this foundation runs through almost the whole primary school stage. Once this knowledge structure has major defects, it will bring great obstacles to the learning of middle school mathematics. Of course, if our students have learning disabilities, teachers can use the relevant theories of educational psychology as support to help students break through the learning difficulties.

In addition, because diachronic principle and synchronic principle coexist in cognitive structure, we can't talk about knowledge structure in isolation without these two principles. Especially under the background of quality-oriented education reform in middle schools, in the face of some deleted middle school mathematics knowledge that has influenced the construction of new knowledge, we need to organically incorporate it into the teaching design according to the teaching progress, and give students the

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possibility to reconstruct it at the junction of old and new knowledge.

3.2 Operation and Mathematical Understanding of Cognitive Schema

Schema is the continuous development and construction of the subject in the process of interaction with the external environment. Piaget, a Swiss psychologist, put forward three competency structures: action schema, symbol schema and operation schema. Among them, the symbol schema already has a complete psychological representation and can be manifested through external actions or behaviors [5-7]. The key period for the development of this symbol schema with integral Gestalt meaning is 2-7 years old. Schemas closely related to mathematics education are operation diagrams, which are logical and reversible, and are the basis of the earliest internal psychological activities of arithmetic operations.

The three processes that play a vital role in intellectual development include assimilation, adaptation and balance. Assimilation occurs when the subject perceives new external objects according to the existing schema, and the subject tends to use any available psychological structure to assimilate new external events. Adaptation occurs when the existing schema is modified to explain a new experience. Obviously, adaptation will affect assimilation, and vice versa. Balance is the main process of intellectual development, including assimilation and adaptation. Balance depicts the transition of the subject from one development stage to another.

3.3 Inspiration to Promote Mathematical Understanding

Mathematics understanding is constantly deepened in the development process of balance-imbalance-re-establishing balance. It is the fundamental task of teaching to help students realize mathematics understanding in this process. According to the arrangement of middle school curriculum content, senior high school students have already learned the primary function and quadratic function in junior high school, but exponential function and logarithmic function are quite different from them. Therefore, when they begin to learn exponential function and logarithmic function after entering senior high school, although the psychological mechanism of assimilation is easy to construct, a comprehensive grasp of the concept of function in a specific type of sense brings them interference and difficulties in understanding, where imbalance occurs, but the adaptation process has not been reconstructed. The psychological mechanism of balance and imbalance has profound guiding significance for teachers to adjust teaching strategies.

In the process of balanced and unbalanced cognitive development, teachers are provided with an excellent opportunity to create students' learning needs and stimulate their learning motivation. The creation of teaching strategies for learning needs can start with the application of functions, point out the value and significance of learning exponential function and logarithmic function to students, or optimize and reorganize the teaching order in combination with the educational theory of "zone of proximal development", and take assimilation as the premise and basis of adaptation. In short, if there is no chance

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to reconstruct the knowledge structure, students' existing mathematical cognitive structure cannot be improved and enhanced. In fact, most of the process of mathematics learning is a process of adaptation, which is also an important factor that makes mathematics difficult to learn.

IV. EMOTIONAL FACTORS

Emotion is a "non-intelligence factor" compared with "intelligence factor", which includes psychological factors such as emotion, will, interest and belief. With the deepening of cognitive psychology research, it is considered that emotional factors also involve intelligence, so it is also called "non-cognitive factors". Compared with primary school, the relationship between teachers and students is more equal between subjects, which is very suitable for "student-centered" teaching [8].

4.1 "Expectation" Mathematics Classroom and Emotional Teaching Language

Whether teachers or students are full of expectations for the class will indicate the success or failure of teaching. This point has nothing to do with the cognitive knowledge structure of mathematics, nor with the logical rules of induction and deduction, but only with the alienation nature of human beings. The famous "pygmalion effect" in psychology shows that the expectation of positive significance of teaching to students can transcend intelligence factors, and it can directly affect the effect of mathematics teaching.

Maintaining and exercising the teaching language ability is one of the basic skills of mathematics teachers. Language is not only the carrier of information symbols, but also the carrier of emotional information [9-10]. The appeal of language is an important skill in classroom teaching. When we need to attract students' attention and stimulate students' interest in learning, we need to change the intonation and use emotional language such as "full of warmth" or "passionate". We need to use "clear" rational language when we focus on demonstrating the ideas and reasoning details of solving problems with blackboard writing.

4.2 Inspiration of Mathematics Learning Attitude to Teaching

It is the stable psychological tendency of the attitude subject towards a specific object, which contains the subjective evaluation of the individual and the resulting behavioral tendency. Mathematics learning attitude refers to students' stable psychological tendency towards mathematics knowledge, which is subjective and behavior-oriented. Some research results show that whether students' learning attitude is positive or not is positively related to their academic performance. Therefore, we should pay attention to guiding students' positive attitude towards mathematics learning. For example, we should convey to students that "acquired efforts" are more important than "innate intelligence" and guide students to pay attention to practice. The particularity of mathematics determines the importance of acquired efforts. For example, passing on the atmosphere of "failure is not terrible" to students through math class and encouraging them to learn from their mistakes, the epiphany after trial and error is also an important way for human discovery and creation.

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V. CONCLUSION

To sum up, mathematics educational psychology is widely used in middle school mathematics teaching. Creating situational patterns can stimulate students' enthusiasm and relieve students' pressure, which is conducive to improving the teaching effect. The essence of education is the education of human subject, and the mathematical education with symbolic mathematical knowledge as the carrier is no exception. Only when the teaching method of mathematical education accords with the scientific law of human cognitive development can students' all-round development be promoted.

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