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Practice and Thinking of Instructional Design under the Concept of Deep Learning

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Abstract **– Based on the concept of deep learning, the teaching design and implementation process are directed to take the core content of mathematics as the carrier, design targeted and specific teaching strategies presenting the concept of deep learning, form personalized teaching plans, guide students to actively and critically integrate new knowledge, and take the knowledge transfer in the new situation as the guidance. The learning method of high-level thinking with the goal of solving complex problems and innovation experiences the process of problem solving and achieves "relational" understanding, so that students can obtain systematic and comprehensive knowledge, ability and attitude, and develop students' core literacy.**

Keywords **– Deep Learning, Instructional Design, High-Level Thinking, Core Literacy.**

I. Development of Deep Learning at Home and Abroad

Ference Marton and Roger Saljo (1976) first proposed the concepts of shallow learning and deep learning [1]. Eric Jensen and Len Ann nickel Sen combined the theory of deep learning with the cases of practical teaching and summarized seven powerful strategies of deep learning [2]. J. Biggs [3] and J. Bransford [4] believe that deep learning refers to the activities designed by teachers to promote students' in-depth understanding and participation, so that students can deeply understand the course content and form their memory when they grow up. The William and flora. Hewlett Foundation believes that through in-depth learning, we can master the core academic content, critical thinking and complex problem-solving skills, effective communication skills, cooperation skills, understanding how to learn and academic thinking mode [5].

Ling He (2005) [6], Xiaoyun Ye (2006) [7], Huisheng Tian (2011) [8] emphasized that deep learning is a continuous learning process, which is reflected in connection construction, understanding and criticism, transfer and application, reflection on the learning process and examination of learning results. Fuhai An (2014) [9], Hua Guo (2016) [10], Yuanxiang Guo (2017) [11] and others put forward that in-depth learning focuses on the essence and thinking methods of learning and the development of high-level thinking. It is in-depth understanding, meaning generation, reflective construction, problem solving, migration and application in real situations. It is a meaningful learning based on reflection and realizing symbol to logic and logic to application, It is a process of active understanding, deep processing, continuous improvement and emotional experience.

II. Basic Concept of Deep Learning

Deep learning theory holds that learning is not only a cognitive process of individual perception, memory and thinking, but also a social construction process rooted in real life, social culture and historical background. It promotes the achievement of learning objectives and the development of high-order thinking ability by deeply processing knowledge information in real situations, deeply understanding the occurrence, development and simple application of complex concepts.

Deep learning emphasizes the organic integration of learning content, the critical understanding of knowledge

learning, the construction and reflection of learning process, the transfer and application of learning and the process of problem solving [12]. Based on the learning environment containing information and knowledge, deep learning focuses on challenging learning themes, wholeheartedly and actively participate, students and students repeated communication (including environmental stimulation), communication and cooperation between students and teachers, experience success, obtain meaningful learning process, generate experience, build knowledge, and improve learning efficiency and will quality.

III. Mathematics Teaching Design under the Concept of Deep Learning

The cultivation of core literacy leads the reform of teaching methods and makes deep learning take root. The teaching design of deep learning builds a bridge between the essence of mathematics and students' understanding learning and application. Deep learning emphasizes the integration of "schema" in situational problems, critical understanding, reflective construction, promoting the analysis and judgment of knowledge differences in new situations, and transferring and applying high-level thinking [12]. Promoting students' independent inquiry, discovery and real understanding, actively constructing personal knowledge system and effectively transferring and applying are the focus of in-depth teaching practice. Enter students' emotions, identify and apply them under various transformation conditions, strengthen the process of thinking development, form network knowledge with logical rules and hierarchical connections through conceptualizati--on and formalization, achieve meaningful understanding and deep-seated internalization, improve problem-solving ability, experience the implicit and dynamic nature of mathematical ideas and methods, and develop mathematical core literacy (See Figure 1).

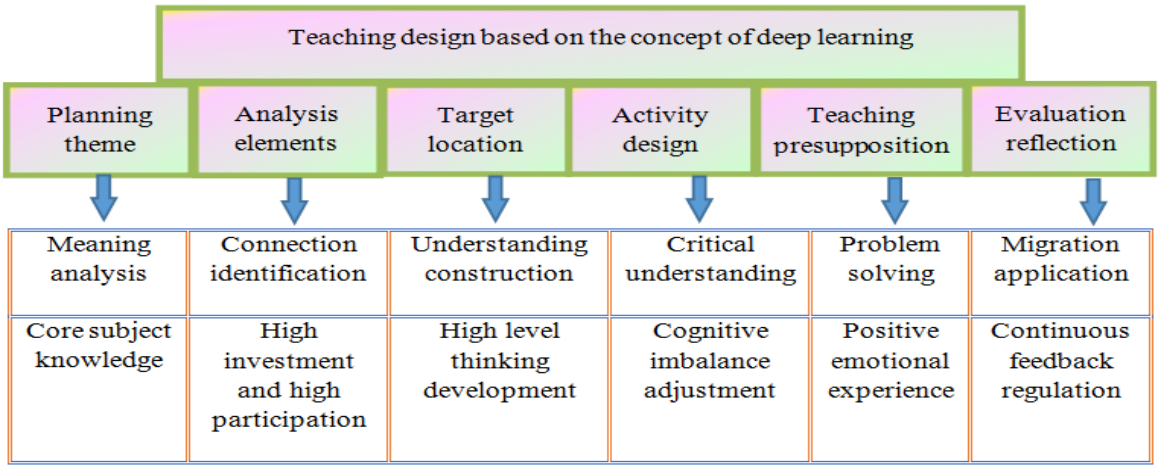

Fig. 1. Mathematics teaching design concept under the concept of deep learning.

A. *Plan and Design Learning Themes Suitable for Students' Development*

Teachers integrate and structure the core knowledge of mathematics macroscopically, optimize the course structure, select the course content, highlight the theme, guide students to understand deeply, help students experience the continuous deepening process and transfer application of knowledge, promote students to improve their daily thinking habits, develop high-level thinking and improve their thinking quality. Deep learning is the natural pursuit of learning. In the process of interaction, students establish a meaningful connection with knowledge, grasp the structure and integrity of knowledge, and experience "what to learn and what to apply".

B. *Grasp the Connotation Structure of Mathematical Elements*

Mathematical knowledge is represented by symbols and the relationship between symbols. The meaning of symbols is the main form of knowledge existence and the main content of teaching transmission. Based on mathematics learning materials (objects) such as situation, text, graphics, structure (relationship), grasp the essence of mathematics, refine the learning theme, deeply process the core content of the discipline, lead students to truly establish a "Recent Development Zone" connection with their learning content, realize the deep coverage of theme learning, and make the learning process become abstract generalization, inductive conclusion The process and system of expressing "results" and variant exercises.

C. *Pay Attention to the Thinking Development Process of Students' Mathematics Learning*

Deep learning promotes the improvement of teaching and learning, which is the process of studying learning from the essential level of learning. Based on students' existing life experience, knowledge reserve and cognitive level, in-depth teaching takes the development of mathematical thinking as the necessary norm of students' thinking, presents the trust and cooperation between students, and forms a learning process focusing on logical thinking, clear organization, argument process, scientific quality and rational spirit.

D. *Constructing Efficient Mathematical Activities Based on Information Technology*

Under the guidance of teachers, students fully participate and devote themselves to activities through interactive participation, feeling, perception, thinking, emotion, will, values and other factors. Students experience the process of generating complete and real knowledge, generate learning needs, acquire knowledge and experience in "learning by doing", achieve understanding and generation of knowledge, improve cognitive structure and develop key abilities, Improve thinking quality and learning efficiency.

E. *Guide Students to Improve their Mathematical Ideas*

Based on the development of core literacy, clarify the "what kind" of teaching essence, scientifically determine teaching objectives, set teaching situations, integrate teaching strategies and methods, implement in-depth learning, study scientific teaching evaluation and a series of specific operable links. The in-depth teaching that can be operated, copied and used for reference can realize the mathematical activities from the macro, meso and micro levels, deepen the understanding of mathematical content, pay attention to the monitoring strategy of "metacognition" [13,14], accumulate the experience of mathematical practice, promote the development of mathematical thinking, form the quality of exploring thinking problems, and develop a meticulous, rigorous and realistic scientific attitude and inquiry spirit.

F. *Evaluation Reflection*

Deep learning brings the experience of learning process, subverts the "mechanical" variant training and the boredom of traditional mathematics learning, and leads students to experience richer learning activities and pleasant emotional experience. Evaluation should not only pay attention to students' learning results, but also pay attention to students' development and changes in the process of problem-solving, focusing on the cultivation of core literacy. Through in-depth learning, students gain the ability to perceive the curriculum value, the mode of critical thinking, the ability to solve complex problems, and the ability to cooperate, communicate, learn and apply, so as to realize the internalization and deepening of knowledge process or thinking quality.

IV. Instructional Design Strategy of Deep Learning

There are various forms for students to screen information and obtain experience, which leads to the diversity and systematizes of teaching strategies. Due to the different original interests, hobbies, knowledge and experience of students, teachers need to design challenging problem situations, close to students' life, pay attention to practice, and adopt a variety of teaching methods to achieve resonance and fun, Lead each student to connect their original "schema" with new knowledge, so that students can understand what to learn, how to learn and how to know how to learn, rather than a simple learning result (See Figure 2).

Teacher intention			Student growth		
Understanding students	→	Experience knowledge	Perceptual teaching materials	←	Thinking development
Information transformation		Curriculum culture	Process method		Question explore
Understanding course	→	Understanding the curriculum standard	Cognitive learning	←	Problem solving
Excavate connotation	→	System and structure	Reconfiguration collaboration	←	Cognition unbalance
Understanding teaching		Knowledge association	Meaning connection		Feedback regulation
Contact processing	→	Thinking law	Generalization and induction	←	Generative construction
Understanding evaluation		Cognitive characteristics	Migration application		Generative literacy
Emotional experience		Emotional attitude	Critical reflection		Multipoint unicom

Fig. 2. Instructional design concept based on deep learning.

A. *A Profound Interpretation of Curriculum Knowledge*

Based on the mathematics curriculum standard, understand the essential content of the discipline, including the representation of knowledge, the way of communication, the display of skills, the relationship between knowledge, and relevant mathematical ideas and methods.

B. *Pay Attention to the Learning Process and Experience*

Depth teaching consciously establishes the relationship between students' experience and knowledge, helps students experience the process of discovering, raising, analyzing and solving problems on the basis of their own knowledge and experience, forms rich experience and produces new mathematical cognition. Experience the relationship between teaching and learning, students and course content, self-learning, etc., and obtain the feelings and attitudes of emotional state.

C. *Determine the Teaching Objectives Focusing on High-Level thinking of the Subject*

Based on the understanding of knowledge symbols and the analysis of core content and learning situation, in-depth teaching actively criticizes and constructs its own knowledge system. The most important thing is to transfer knowledge to its own "schema" and solve problems in the new environment, so as to establish a bridge between the specific content of the discipline and the learning characteristics of students, it is a learning method aimed at developing students' own high-order thinking and cultivating mathematical literacy.

D. *Promote the Cultivation of Students' Mathematical Core Literacy*

Under the concept of deep learning, teachers' "teaching" aims at students' "learning", and technology promotes understanding learning, critical high-level thinking, active knowledge construction, effective knowledge transfer and real solution of problems. The learning environment of respect, trust, understanding and cooperative participation not only promotes the understanding and mastery of mathematical knowledge, but also deeply excavates the methods, theories and values contained in its knowledge, but also pays attention to the hierarchical and continuous monitoring of whether the learning process has achieved the accumulation of mathematical core literacy.

V. Teaching Design Method of Deep Learning

A. *In Depth Teaching Design Guided by the Development of Core Literacy (Figure 3)*

Based on the concept of core literacy, in the real social situation and mathematical problem situation, grasp the level of teaching design, pay attention to critical learning and reflection, lead the development of high-level thinking, cause students' metacognitive monitoring, help students enter long-term memory, reflect and regulate the learning process, make learning deepen and finally solve problems Improve the attitude and humanistic cultivation of mathematics learning.

Teaching behavior	Resource allocation	Discussion and exchange	Abstract logic	Feedback evaluation	Innovation and creation	Expand perception
Student literacy	Mathematical activities	Mathematical experience	Mathematical thinking	Mathematical cognition	Mathematical ability	Mathematical view
Deep learning	Mathematical thinking	Mathematical understanding	Assimilation adaptation	Problem solving	Mathematical thought	Cognitive attitude
Student behavior	Interest experience	Thinking relevance	Meaning structure	Application migration	Reflective criticism	Humanistic cultivation

Fig. 3. Core literacy oriented mathematics deep learning.

B. *Depth Teaching Design Based on High-level Learning (Figure 4)*

The design and implementation of deep learning is based on Teachers' correct understanding of curriculum, students, teaching and technology. On this basis, they creatively carry out teaching design, organization and reflection. Deep learning has experienced situational activities, understanding learning, cognitive assimilation, generation innovation and practical application.

① Design mathematical activities based on the characteristics of deep thinking;

② Demonstrate and "scaffolding" thinking and reasoning;

③ Comprehend the significance of high-level thinking operation;

④ Think about variant exercises and integrate the cognition of existing experience;

⑤ Understand the value of thinking methods;

⑥ Understand the connotation of mathematical application and mathematical attitude.

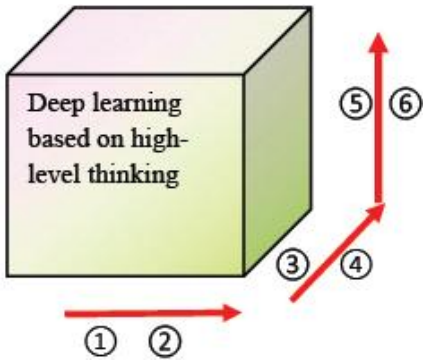

Fig. 4. Deep learning based on high-level thinking.

C. *Deep Teaching Design for Developing Deep Mathematical thinking Quality*

Deep learning integrates the learning content of meaning connection, increases the inquiry behavior in classroom teaching, guides students to use their own experience, judgment and thinking to deeply analyze new problems and principles, question conjecture, analogical reasoning, critical construction, reflection and correction, and establish a connection with existing knowledge to build a relatively perfect cognitive structure. In this way, experience is transformed into knowledge, and knowledge is transformed into materials related to students and capable of operation and thinking. After solving a problem, they study new problems. In the process of constantly solving problems, they promote the improvement of students' practical innovation ability, form mathematical thinking methods and form core literacy.

Take the design of root seeking formula of univariate quadratic equation as an example (Figure 5).

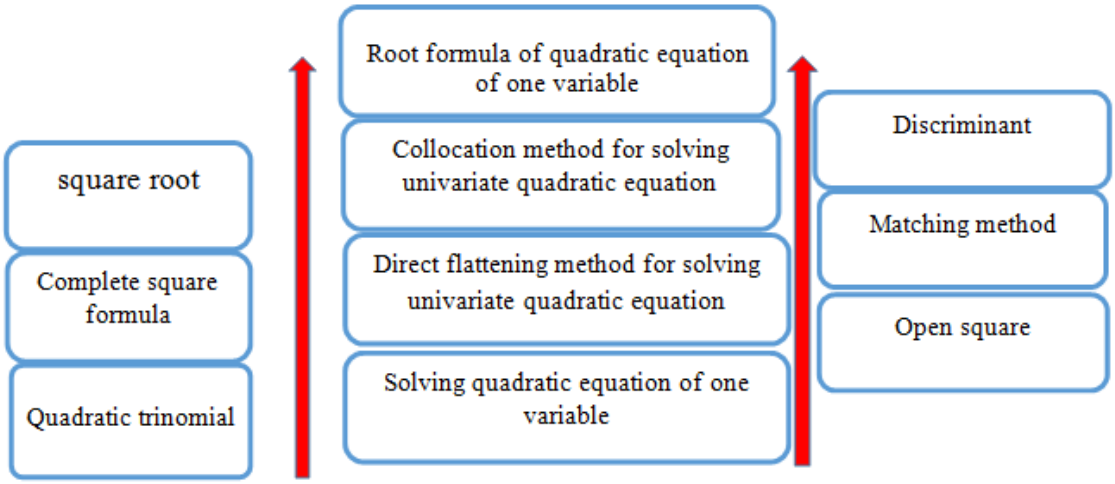

Fig. 5. Knowledge network structure of root seeking formula of univariate quadratic equation.

D. *Integrating the Concept of Mathematical Culture into In-depth Teaching*

① Cultural guidance transforms students' mathematics learning ability into life ability, observation ability and expression ability, further understands mathematics, likes mathematics, loves mathematics, pursues innovative spirit, and promotes knowledge.

② Learning and moral cultivation. Appreciate the beauty of mathematics, and really infiltrate the charm of mathematical culture into teaching materials, classrooms and teaching, so as to realize the speculation from mathematical knowledge to mathematical thinking and philosophy.

③ According to the age characteristics of students, the requirements of school sections and the actual situation of the school, carry out rich and colorful cultural education, popular science, sports, art, labor, reading, interest groups and community activities in different grades and levels according to local conditions, so as to meet the diversified needs of students to the greatest extent.

VI. Analysis on the Impact of Teaching Design of Deep Learning on Classroom Teaching (Figure 6)

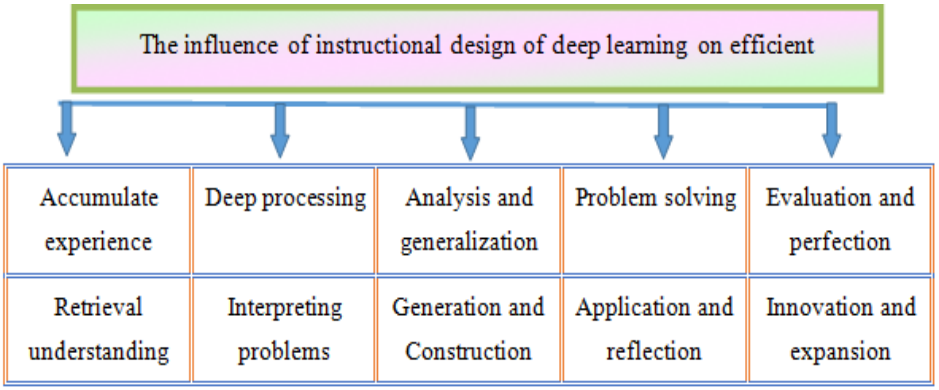

Fig. 6. Research on the impact of instructional design based on deep learning on efficient classroom.

A. *Accumulate Experience and Take the Initiative to Understand*

Deep learning is based on the analysis of the essence of the implementation of the subject content, including the knowledge and skills of the content, the relationship between knowledge, relevant mathematical ideas and methods, etc., and transforms the subject knowledge into the relationship between knowledge units and blocks, so as to make it an object that can be operated and processed by thinking. Based on the scenes in life, the concept of equipotential angle, the concept of intersecting lines and parallel lines, and the drawing method of connecting parallel lines (the equipotential angles are always equal), through measurement, clipping, intuitive imagination, and through their own thinking, selectively pay attention to the graphic characteristics when the equipotential angles are equal, making the learning process a dynamic, rich and vivid cognitive practice process.

B. *Deep Processing, Interpreting Problems*

Understanding how students operate in depth, process teaching materials, transform subject knowledge into their own "schema", criticize and accept, and can clearly grasp students' points of interest, difficulties and key clues in learning. Explore and understand in situational activities, think more, abstract generalization and representation is that as long as the equipotential angle is equal, the two straight lines are parallel, which

promotes the development of experience into long-term memory. Different students get the same conclusion while thinking deeply.

C. *Analysis and Generalization, Generation and Construction*

According to course materials, learning scenes, organizing knowledge and selecting the presentation mode of students' achievements, design teaching resources that students can conduct in-depth thinking operation and processing, guide students to participate in exploration activities of parallel line judgment, emphasize the construction and generation of meaning, generate their own mathematical cognitive structure, construct concepts or publish research results, Develop the relationship with "equal equipotential angles and two straight lines parallel". As long as the internal error angles are equal (the sum of the internal angles of the same side is 180°), the two straight lines are parallel, and give a formal proof process based on deductive reasoning.

D. *Problem Solving, Application and Reflection*

With "high input, high cognition and high output", students judge the newly acquired parallel lines according to their learned experience and knowledge and process them in-depth in variant training. This process gradually forms reflection, criticism and evaluation on the judgment of parallel lines, that is, the seemingly scattered and disorderly "knowledge units and blocks" in the communication, exchange, question, answer. In the process of dialogue and sharing, promote the continuous promotion of students' in-depth learning in class, pay more attention to the connotation of the learning process, realize problem-solving, form the transfer of knowledge and thinking methods, and develop students' core literacy.

E. *Evaluation and Improvement, Innovation and Expansion*

In the deep learning of mathematics, through students' full exploration, thinking, representation, communication and reflection, they have experienced the process of "experience and perception, identification and analysis, processing and transformation, application and migration, evaluation and innovation", linked the "schema" into logical and related structural knowledge, grasped the internal relationship of parallel line judgment, and constructed mathematical thinking methods, Finish the learning task with high quality, feel the scientific value and application value of mathematical knowledge, and lay a good foundation for the learning of parallel line nature.

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