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Constructing the Development Strategy of Core Literacy Based on Deep Learning

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Abstract **– Based on the in-depth learning concept of "research and analysis link, understanding and construction, modeling migration and critical speculation", lead students to practice, use their brain and mouth, carry out mathematical inquiry activities, and promote the occurrence of high-level mathematical thinking. Teachers lead students to actively and critically integrate knowledge in new situations, put forward hypotheses, refine and process problems, and form new mathematical concepts and models. Based on the analysis of problems, students can prove or identify through examples, aiming at solving complex problems and innovation, transfer and apply the core knowledge of mathematics, develop the core quality of mathematics, and become a person with noble morality.**

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

I. Brief Introduction of Mathematics Core Literacy

OECD (1997) first mentioned the name of “core literacy”. In September 2016, the “core literacy of Chinese students' development” was released, which defined the connotation of core literacy from cultural basis, independent development and social participation, and cultivated “people with all-round development”. Xiaoya He (2016) from mathematical calculation, reasoning, consciousness. The connotation of mathematical literacy is described from the perspective of ideological methods, emotional attitudes and values [1]. Binyan Xu and Jinfa Cai (2016) pointed out that mathematical literacy is the integration of mathematical knowledge, mathematical ability and emotional attitude values [2], which reflects the essence and thought of mathematics. The mathematics curriculum standard for senior high schools (2017) points out that the core quality of mathematics is “the key ability and thinking quality related to mathematics that students should have and can meet the needs of lifelong development and social development”. It is reflected in the structure of knowledge, which is divided into symbolic representation, logical structure and meaning system, the understanding of mathematics knowledge and the promotion of their grasp of subject structure. To gain the edification of mathematical thought, encourage students’ in-depth study, devote themselves to helping students develop knowledge, ability and accomplishment, promote more successful learning, and form a unique spiritual temperament and cultivation after internalizing mathematical knowledge and mathematical thinking methods according to their own experience and thinking mode [3].

II. Review on the Research Status of Deep Learning

F. Marton and R. saljo (1976) first proposed deep learning [4]. J. Biggs (1982) [5], J. Bransford (1988), N. Entwistle (1997, 2001) [6] and others believe that deep learning is to enable students to deeply participate in activities, understand learning contents, link and store them in the original knowledge and experience. The William and Flora Hewlett Foundation believes that through in-depth learning, we can master the core knowledge content, critical thinking and complex problem-solving skills, effective communication skills, cooperation skills, understanding how to learn and academic thinking mode [7]. Egan (2010) focused on the co-

-nsistency and relevance of deep teaching and deep learning.

Ling He (2005) [8] and Xiaoyun Ye (2006) [9] emphasize the guidance and development of students' thinking with the concept of deep learning. Fuhai An (2014) [10], Hua Guo (2016) [11], Yuanxiang Guo (2017) [12] and others proposed that in-depth learning is to realize symbol to meaning, and is an understanding learning based on reflection and developing high-order thinking.

Deep learning promotes the achievement of learning objectives and the development of high-level thinking ability through deep processing of knowledge and information in real situations, deep understanding of the occurrence, development and simple application of complex concepts [12]. Based on the meaning construction of deep learning, the way to solve problems is achieved. Active exploration, deep thinking, meaning understanding, variant thinking, transfer and application reflect the connotation of mathematics learning, lead students to think deeply, and help students develop knowledge, acquire ability and generate literacy. It is a more successful learning.

III. Teaching Strategy Based on Deep Learning

D. Jonassen and S. Land pointed out that learning is essentially a process of social dialogue [13], a structural process in which the original knowledge units, blocks and system structures in students' brains are continuously connected with the information contained in the new environment. The core feature of deep learning is understanding learning based on high-order thinking. The development of high-order thinking ability is helpful to promote and realize deep learning. Through the mutual transformation of information and knowledge contained in the learning environment, the multi-point integration (including the integration of environment) and representation results between students and students and students and teachers, students can understand that knowledge and experience are generated and constructed. Deep learning emphasizes the deep integration of learning contents, focuses on the construction and reflection process of mathematics core knowledge learning, pays attention to the process of problem solving, the transfer and application of learning methods, and pays attention to the critical understanding of learning strategies.

Based on students' original cognitive experience, build a problem situation platform, develop deep thinking, solve mathematical problems and develop core literacy. Therefore, establish the teaching goal of high-order thinking development, create mathematical activity situations to promote deep learning based on “research and analysis link, understanding and construction, modeling migration and critical speculation”, integrate meaningful and connected learning contents, guide students to actively experience perception, move towards students' deep thinking and understanding, and actively reflect on criticism, generation and construction. Generate mathematical understanding with “relational connotation”, choose the evaluation method of continuous attention, and make the in-depth learning achieve efficient teaching. The knowledge highlights its scientific value, application value and cultural value (Figure 1).

<table>
<tr><th colspan="6">Teacher Intention</th><th>Deep Learning</th><th colspan="6">Student Growth</th></tr>
<tr><td rowspan="2">Undersand-ing students</td><td rowspan="2"></td><td rowspan="2">Informati-on conversion</td><td rowspan="2"></td><td>Experience fusion</td><td rowspan="2">Research and analysis link</td><td>Perceptual teaching materials</td><td rowspan="2"></td><td rowspan="2">Question-ing inquiry</td><td rowspan="2"></td><td rowspan="2">Thinking develop-ment</td></tr>
<tr><td>Curriculum</td><td>Experience</td></tr>
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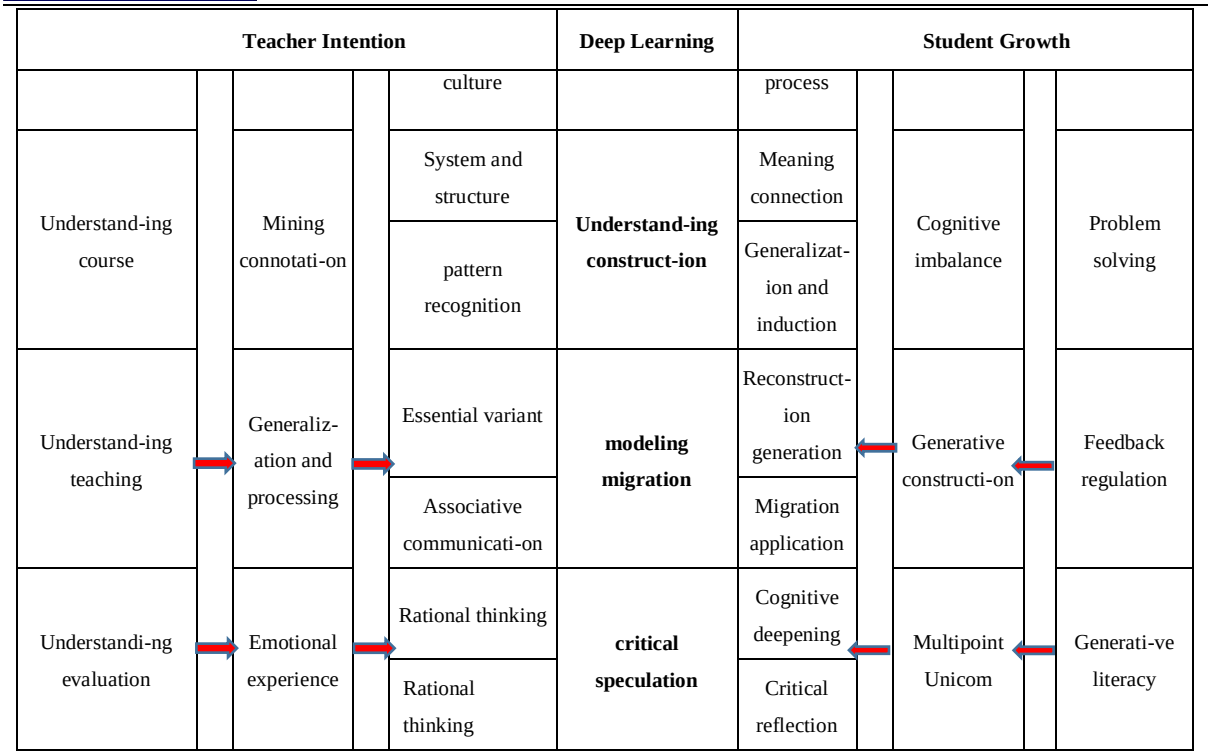

Fig. 1. Teaching Strategy Based on Deep Learning.

A. *Research and Analysis Link*

Deep learning is based on mathematical situation and mathematical activities, on the basis of high participation and deep thinking, it connects the external knowledge with the screening significance of students' cognitive structure, and focuses on developing students' learning ability, so as to connect memory, understandin--g, construction, correlation and reflection, and develop systematic mathematical thinking ability.

B. *Understanding Construction*

"Activate" the static knowledge, identify the experience and knowledge as well as the possible correlation (mode), endow the knowledge with symbolic mathematical meaning according to the original experience, break the original balance state in the dynamic process of "schema" connection, and sort out, transform and reorganize the psychological representation of the mathematics learning object, so as to summarize and refine the essential characteristics and laws of the mathematics object, Reach a new balance again, form a new knowledge structure, and feel the tempering and significance of rich thinking methods and thinking quality contained in the process of knowledge construction.

C. *Modeling Migration*

Using the deep thinking of layers and layers, from abstract to concrete, complex problems are transformed into simple problems to solve, unknown problems are transformed into known methods to solve, highlighting the essence of mathematics learning, the process of transforming objectivity into symbols and relationship representation into models, and the knowledge learned is transformed into students' core literacy, leading students to participate in thinking and thinking in the process of knowledge learning Essential variation, expression, communication, questioning and application, and promote the migration of thinking methods (models) to new problem situations, make new decisions and solve new problems.

D. *Critical Speculation*

Lead students to further insight into the essence of mathematics core knowledge, understand the essence of mathematics thinking and methods, and experience the true meaning of mathematics learning process, so as to achieve high-level mathematical understanding reflect on how you integrate into the mathematical situation, how you intervene in thinking, and how the mathematical connection develops. What original mathematical experience, what new mathematical ideas, mathematical methods and mathematical skills you have learned, analyze the differences between predecessors' and your own thinking modes, cultivate the spirit of conscious exploration and rational thinking, and form the key ability of independent development and correct values.

IV. Development Strategy of Core Literacy Based on Deep Learning

Carry out the analysis of specific problems in appropriate learning situations, guide students to participate in communication, activate students' original "schema", build a connection channel between old and new experience, frankly communicate or argue with peers, expose the thinking level of problems, establish extensive associations, realize progressive thinking, achieve general understanding of problems and in-depth understand--ing of mathematical concepts. Grasp the essence of mathematical knowledge, improve cognitive structure, develop key abilities, obtain mathematical core knowledge and improve students' core literacy (Figure 2).

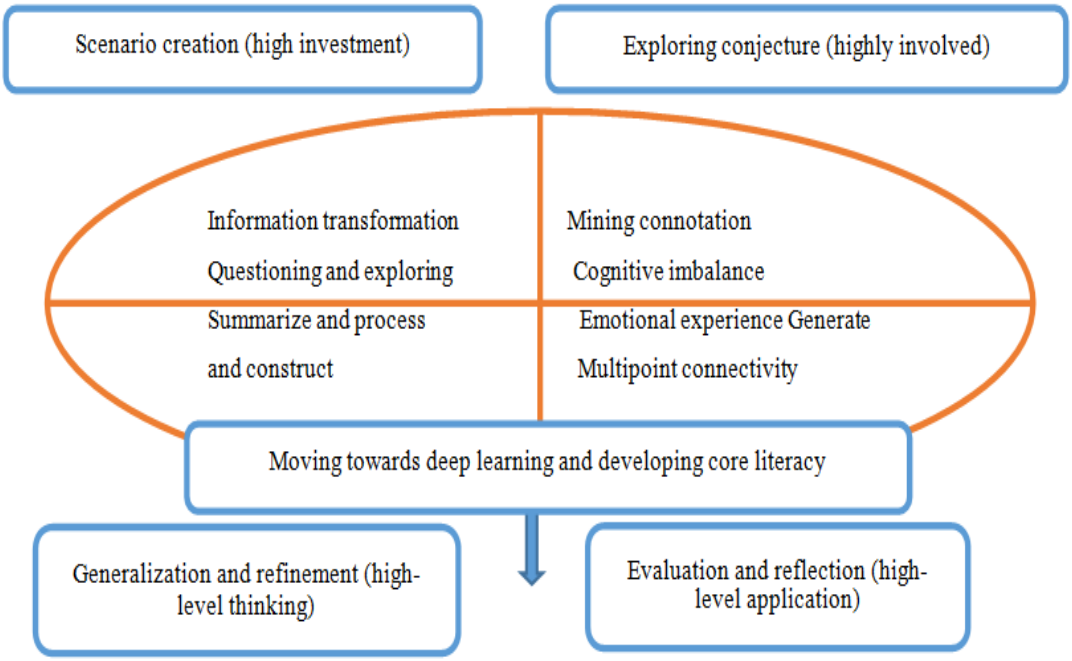

Fig. 2. Development Strategy of Mathematics Core Literacy.

A. *Representable Mathematical Meaning Can be Transformed Based on Experience*

Case: in the situation of multiplication rule of rational numbers, when the rainy season comes, it rains one after another, resulting in the rise of the reservoir water level. Therefore, it is necessary to prevent flood, release water from the reservoir and reduce the water level, so as to ensure the safety of people's lives and property.

Based on the situation, students explore and question, relate the structure of mathematical activity experience, put forward mathematical problems, experience the generation process of problems, experience the mathematical connotation structure, analyze and solve problems.

Situational question: when the rainy season comes, it rains and the water level of the reservoir rises, with an average of 2 cm per day. What is the water level after 3 days? What was the water level three days ago? Flood control, reservoir discharge, water level drop, average 2 cm per day, what is the water level after 3 days ? What was the water level three days ago?

B. *Excavate Connotation, Associate knowledge, Understand and Construct*

Put forward questions, through the process of observation, thinking, abstraction, comparison, operation and reasoning, proof and so on, establish the dynamic meaning connection between old and new knowledge and experience, assimilate or adapt, adjust the original cognitive balance, summarize, refine, summarize and express, directly incorporate the psychological image of mathematics learning objects into their own cognitive structure, and obtain the mathematical model.

① When it rains, the water level of the reservoir rises, with an average of 2 cm per day. Ask, what is the water level after 3 days?

Expressed as $2\times3=6$, directly converted to integer multiplication rule.

② Flood control, reservoir discharge, water level drop, average 2 cm per day. Ask, what is the water level after 3 days?

Expressed as $-2\times3=(-2)+(-2)+(-2)=-6$, convert it into the addition rule of rational numbers. Through practical operation (thinking) and abstract generalization, the situational problems are expressed in mathematical language and verified by reasoning (specific application), the connection of meaning and the process of solving problems are constantly adjusted, so as to guide students to clearly explain the mathematical meaning in what kind of situation, and apply these knowledge to establish connection with other new problem situations or real and objective situations, so as to form a new way to understand the meaning, adjust and balance the "schema" of these knowledge in the brain, innovate the model relationship and solve problems, so as to truly understand the meaning of knowledge.

C. *Generalizing Processing and Deepening New Experience and Mathematical Significance*

Using the meaning of rational number multiplication (addition) (using the original knowledge and experience), connection analysis, rearrange and arrange the "information meaning" in the problem, directionally select and rearrange the coding structure of "schema", adjust new experience, reconstruct and expand the connotation of new mathematical meaning, and move towards deep thinking. It embodies the process of integrating mathematical knowledge and methods, and shows the high-level mathematical thinking structure such as mathematical operation and reasoning, relationship deduction and structural change.

③ When it rains, the water level of the reservoir rises, with an average of 2 cm per day. Ask, what was the water level three days ago?

Expressed as $-2\times3=(-2)+(-2)+(-2)=-6$, first adjust the relationship between before and after time, and use the original experience, that is $-3=-1\times3$, $2\times(-3)$, transform into $2\times(-3)=2\times(-1)\times3=-(2\times3)=-6$.

④ Flood control, reservoir discharge, water level drop, average 2 cm per day. Ask, what was the water level t-

-hree days ago?

Expressed as $(-2)\times(-3)=(-2)\times(-1)\times 3= -(-2\times 3) = 6$, adjust the relationship based on ③ and use ② to obtain the result.

D. *Emotional Experience, Multipoint Unicom, Critical Reflection*

Emotional experience in situational learning activities, critical thinking, reflection and questioning, the integration of new mathematical cognitive structures, the construction of knowledge and generation methods, help students deeply understand mathematical concepts, and establish the connection representation and critical reflection of mathematical models, so as to truly and thoroughly understand the essence of concepts. Students can use the cognitive way of mathematical thinking and problem solving to apply the experience of problem solving process to the learning of new problems. Review the learning process and variant exercises, enable students to obtain systematic and comprehensive knowledge, ability and attitude in reflection, and complete the integrated construction of mathematical system.

In the process of actively constructing new experience based on the concept of rational number multiplication generated by itself, these related knowledge and methods form a new regular coding structure, which is reflected in the appropriate analysis of general problems, the translation of problems into their understandable representation forms, conscious cognitive deepening, multi-point connection, critical reflection, form a general rational number multiplication rule, and apply the variation.

V. Core Literacy Development Measures Based on Deep Learning

A. *From Perceptual Instance to Abstract Generalization*

Perceptual learning materials are the basis of students' learning. Without being integrated into the mathematics learning situation, it is impossible to understand the essence and law of mathematics concepts according to the requirements of teaching content, provide students with rich mathematics learning materials (situations) in a purposeful and planned way, and use high-order thinking (understanding, application, analysis, evaluation and creation) to guide students to observe, think and compare on the basis of existing cognition, combined with life examples and organize students to carry out mathematics inquiry activities, consciously highlight the perceived mathematics learning materials from the background, so that students can clearly perceive the relationship between the original experience and the new learning materials, turn static knowledge into active thinking connection, and leave students with a clear and profound concept learning process. It is a step-by-step process to pay attention to the process of concept formation, the deepening of knowledge and the quality of thinking.

B. *From Topic Learning to Logical Reasoning*

In thematic learning, the “unit”, relationship and structure of mathematical knowledge are interrelated, highlighting the relationship and structure among mathematical knowledge, principles and basic ideas, and highlighting the process of mathematical knowledge, set up a “Recent Development Zone” in “doing mathematics”. Theme learning deepens cognition, integrates structure, highlights the formation of “four basic” modules, and deeply thinks and processes the learning objects. Experience, knowledge, thoughts, emotional attitudes and values have been accumulated for a long time. The process of mathematical modeling and

problem-solving will be integrated into students' thoughts and minds, the construction of knowledge and the ability to solve problems will be gradually completed. For example, in teaching the nature of "isosceles triangle", we can first guide students to fold isosceles triangle, think about axial symmetry, angular bisector of midline, high line and top angle from the trace of folding, find the easiest way to form a congruent triangle, find the easiest way to think that the two bottom angles are equal, and compare other ways, so as to guide students from operation to intuitive imagination, and compare, analyze and synthesize, solve problems, and make thinking profound.

C. *From Problem Solving to Leading Hobbies and Interests*

In the design of problem teaching, it deeply reveals the internal relationship between the old and new mathematical knowledge by means of perspective correlation, knowledge correlation and method correlation. In teaching practice, it pays attention to guiding students to solve problems with existing knowledge, methods and perspectives in the face of new and complex problem situations, and observe reality from the perspective of mathematics through rational thinking, learn the language, graph (chart), symbol and relation expression of mathematics, construct mathematical model, carry out mathematical communication, lead the development of thinking in depth, cultivate rigorous quality, promote the promotion of image and intuition to abstract generalization and logical reasoning, and realize the transfer and application of mathematics learning lead students to participate in "doing mathematics" and gain relatively effective mathematical experience, so that some important mathematical knowledge can exchange, communicate and discuss problems related topics with the help of seeking some specific visual support, carry out multi-dimensional, multi-level and mutual exchange cooperation, and consciously regulate the process of solving problems, promote students to understand the knowledge structure level, logical sequence and information development process of problems. For example, based on the experience of "primary function and univariate primary equation", learn "the difference and connection between quadratic function and univariate secondary equation", so as to make the teaching process become an active exploration, guess and screening driven by students' internal emotion and urgent learning motivation. Determine the possible conclusions, effectively construct their own mathematical understanding, obtain the understanding and mastery of mathematical learning methods, explain the process of obtaining answers, experience the process of reflection generation and construction and mathematical thinking, test and analyze the answers they obtain, share their own inquiry process with others, and further transfer and apply this process.

D. *From Hands-On Operation to Intuitive Imagination*

Visual imagination is based on the ideological methods of understanding graphics, such as position, shape, relationship, measurement and representation, to understand the position relationship, morphological change and motion law of things, or use graphics to describe the change of mathematical relationship, analyze the connotation of mathematical problems, establish the relationship between graphics and algebraic representation, and explore the idea of solving problems, build intuitive models and methods of mathematical problems. Intuitive imagination is mainly reflected in the use of geometric intuition and spatial imagination to solve mathematical problems with abstract generalization and logical reasoning. For example, in the "high triangle" learning, lead students to operate, think deeply, summarize, reflect and criticize, cultivate students' intuitive imagination literacy, and verify reasonable reasoning. Therefore, in the process of solving mathematical

problems, we should organically combine problem representation, schema construction and students' thinking, so as to generate mathematical core knowledge [14].

E. *From Variant Thinking to Thinking Construction*

Many mathematical concepts are closely related. Concepts can be transferred to "variants" by connecting relevant experience and original concepts "Variant" refers to the use of effective information, extensive comparison and association, the analysis of new mathematical relationship structure, or the distinction of essence from hidden forms. It can study not only the problem itself, but also other related problems.

Based on "Pre-training + Fine-training" (Jason Kosinski, 2014), develop students' in-depth thinking strategies for mathematical problem solving, use the method of deep learning mobility, variant thinking, expand thinking connection [15], show the occurrence and development process of mathematical knowledge, and form the knowledge structure system through the connection of relevant knowledge points. For example, based on the direct open square method to solve the univariate quadratic equation, study the matching method and root seeking formula to solve the univariate quadratic equation, infiltrate and transform the thinking and methods, and form the knowledge module and logical relationship of the univariate quadratic equation solving method, so as to analyze and judge its own cognitive structure, effectively promote the integrity and interrelated construction of knowledge, and realize deep learning.

F. *Data Analysis from the Perspective of Context*

We live in an economic society in the era of big data. Almost everything around us is integrated in data. Modern society has gradually formed a way of thinking to speak, explain problems and explain things with data. The most important data analysis and corresponding conclusions are different from simply displaying numbers with PPT. Valuable data is not made or imagined out of thin air, it must be related to the specific situation.

In specific situations, it is necessary to collect and sort out data according to practical problems, accumulate rational experience of observation, experiment and operation, and then analyze the data based on data analysis methods, using data analysis software and data statistics methods, connect, process, dispose and convert in specific situations, explain the value and significance of relevant data, and achieve learning objectives, Accumulate thinking experience, develop high-level thinking ability, form and develop mathematical core literacy, and understand mathematical thought.

VI. Experience and Summary

A. *Build "Teaching" on the Basis of Students' "Learning"*

Based on the in-depth learning concept of "information transformation, connotation excavation, generalizati--on and processing, emotional experience", mathematics learning breaks the segmentation between mathematical knowledge. The curriculum content pays more attention to students' personal practical activities, opens up the integration between knowledge, attaches importance to the formation and development process of concepts and the transfer and application of knowledge, and favorably supports students' learning and teachers' teaching. Induce the occurrence of high-level mathematical thinking and promote the improvement of thinking strength, it emphasizes that students should constantly try to study new mathematical situations and explore new learning methods in the learning process, constantly try to use new experience to assimilate new knowledge,

cultivate students to try to use their own methods, and filter, screen, analyze and process the obtained information, so as to enable students to form their own inquiry strategies for knowledge learning, “This process is not only used for problem solving, but also enables students to experience and understand the methods hidden behind inductive definitions, hypothetical problems, use proofs, improve argumentation and so on” [16].

B. *Deep Learning Permeates the Ideas of Science, Technology and Society (STS)*

Deep learning has changed students' learning style, showing the experience of problem exploration based on mathematical situation, the path of problem solving, the optimal expression of model language, the demonstration of obtained conclusions (conjectures) and the expression of mathematical model. Students have also experienced the training of will in the process of problem solving, the refining and application of ideological methods and the reflection on the above-mentioned activity process.

Students learn actively under the learning concept of "questioning and inquiry, cognitive imbalance, generation and construction, and multi-point connection", and actively build knowledge in deep-seated participation. After comparative analysis, they study the differences between theory and practice, verify conjectures and theories, understand the development process of mathematical core knowledge, and are easy to be combined with other disciplines, make mathematical knowledge related to other disciplines, combine and mobilize students' knowledge, emotion, meaning and behavior, experience the aesthetics, delicacy and appreciation in the process of learning mathematical core knowledge and constructing mathematical model, achieve the best learning benefits, develop mathematical core elements, and then deeply experience the social and humanistic value of mathematics.

REFERENCES

[1] X.Y. He. Reflection on the indicators of mathematics core literacy. Research on Mathematics in primary and secondary schools (South China Normal University Edition), 2016, (13): 1-4.
[2] J.Y. Cai, B.Y. Xu. On the core literacy of mathematics and its construction. Global Education, 2016, 45 (11): 3-12.
[3] S.H. Lv, Z.Y. Wu. Connotation, characteristics and system construction of mathematics core literacy. Curriculum, Teaching Material and Method, 2017, 9 (37), 12-17.
[4] F. Marton, R. Saljo. On Qualitative Differences in Learning: I-Outcome and Process. British Journal of Educational Psychology, 1976, (46): 4-11.
[5] J.B. Biggs. The Role of Meta learning in Stared Processes. British Journal of Educational Psychology, 1985: 185-212.
[6] T.W. Smith, S.A. Colby. Teaching for Deep Learning. The Clearing House, 2007, 80(5):205-211.
[7] William, Flora Hewlett Foundation. Deeper learning strategic plan summary education program. Menlo Park: William and Flora Hew Lett Foundation, 2012.
[8] L. He, J.H. Li. Promote students' in-depth learning. Modern teaching, 2005, (05): 29-30.
[9] X.Y. Ye. On shallow learning and deep learning Research and exploration. Introduction of Educational Technology. 2006, (1):19-21.
[10] F.H. An. Research on classroom teaching strategies to promote deep learning. Curriculum, Teaching Material and Method, 2014,34 (11): 57-62.
[11] H. Guo. Deep learning and its significance. Curriculum, Teaching Material and Method , 2016, 36 (11): 25-32.
[12] Y.X. Guo. Deep learning: essence and concept. New teacher, 2017,(07):11-14.
[13] David, Jonassen. Theoretical basis of learning environment (Second Edition). Shanghai: East China Normal University Press, 2015,10
[14] L.M. Zhu, H.Q. Hu, Y.P. Ma. Understanding and generation path of mathematics core literacy--taking high school mathematics curriculum as an example. Journal of Mathematics Education.2018, 27 (1): 42-46.
[15] Y. Jason. How transferable are features in deep neural networks?. NIPS 2014,2014,11.
[16] B.Y. Xu. Prospect of Mathematics Education. Shanghai: East China Normal University Press, 2003, 01.

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