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An Exploration of Deep Learning Based on Core Literacy Development in Mathematics

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Abstract: Deep learning focuses on the improvement of students' higher-order thinking skills, and deep learning and the development of disciplinary core literacy go hand in hand. This paper takes how to construct a mathematical problem-solving classroom as a base to explore how to promote the cultivation and development of disciplinary core literacy through deep learning and tries to provide a proven path in teaching and learning.
Keywords: Deep learning; Subject core literacy; Thinking classroom

1. Deep learning and core literacy in mathematics

The term deep learning is a term that first appeared in the field of machine learning to allow machine learning to go beyond shallow learning. In the field of education, deep learning requires learners to master core knowledge for the purpose of advanced thinking. In this paper, deep learning is a meaningful learning process in which students are fully engaged and deeply experienced in a deep (challenging) learning task or topic, with the guidance and direction of a teacher, and their thinking is advanced and developed.

To successfully carry out deep learning activities, we must deeply understand and appreciate the connotation of deep learning: ① "Deep" is not a measure, let alone adding difficulty to learning. ② "Deep" is a portrayal of the qualitative learning state, which is related to the degree of learning investment, thinking level and cognitive experience, etc.; ③ Deep learning is a kind of understanding learning that promotes knowledge construction, and has the pursuit of critical absorption and selective use of learning contents; ④ Deep learning is purposeful learning that deepens migration application to achieve problem-solving.

Core literacy in mathematics is developed progressively in the learning process of mathematical knowledge. The core literacy of mathematics does not weaken the learning of knowledge, but puts forward higher requirements for the acquisition of knowledge, emphasizes the key abilities, necessary character, and values behind the knowledge, and reveals the deeper value of knowledge. How to explore the deeper value of knowledge? The attributes of the core literacy in mathematics make deep learning an obvious choice. The development of core literacy in mathematics is in turn a good way to promote deep learning, which leads to the transformation of general thinking to higher-order thinking, from conventional learning to deep learning, and the continuous condensation of core literacy in mathematics[1].

2. Exploring pathways for teaching mathematics that point to deep learning

Using deep learning theory as a guide and grounding it in and throughout regular classroom instruction can better and sustain students' mastery of core knowledge, grasp mathematical ideas and methods, and trigger higher-order thinking activities. In this paper, we take problem-solving as the landing point and describe the strategies for implementing deep learning theory in mathematics teaching.

2.1 Create problem situations to stimulate a state of learning engagement

There are multiple goals for teaching in the regular classroom, nurturing and developing students' general literacy, humanism, aesthetic appreciation, diversity of perspectives, etc. But how to cultivate and develop? Enhancing students' interest in learning is the key. The Western scholar DeGarmo once said: "Good questions are good education", which means that questions that promote education can also be called "good questions". "Good questions" can trigger cognitive conflicts and attract students, and can effectively stimulate students' internal motivation and transferability.

For example, in the study of the lesson of determining the parallelism of plane and plane, it can be created that when workers paste ceramic tiles, they often use the level to cross place on the ceramic tile surface twice. If the bubbles of the level are in the center twice, they can judge that the ceramic tile is parallel to the ground. An exploratory question is raised: why do workers only check twice and cross place it? Stimulate students' thirst for knowledge and make students enter the state of high investment. What are the conditions for teachers to guide and ask students to determine the plane in teaching? (Two straight lines parallel or intersect), fully activate students' "Recent Development Zone", make students deeply feel that mathematics is everywhere in life, help to cultivate

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students' geometric intuitive core literacy, and further stimulate students' enthusiasm for exploration

2.2 Focusing on problem transformation and fostering higher-order thinking skills

Constructivist learning theory asserts that the learning process is an active construction of the learner's cognitive thinking activities. Most mathematical problem-solving processes can be viewed as essentially meaning-making processes, often requiring information processing, critical information analysis, and representation. Grasping key information is the turning point of problem-solving in deep learning, and the process of problem-solving transforms the problem and constantly searches for the best solution to the problem, fully reflecting the mathematical idea of conversion.

For example, all edge lengths of a tetrahedron are $\sqrt{2}$, find the surface area of the ball outside the tetrahedron. For this problem, ① Ask the question: which key condition do you need to know to find the surface area of a ball? How do you find the radius of a ball? What are some convenient ways to find the radius of a ball other than finding the center of the ball directly? ② Analytical reasoning: you can put the tetrahedron described in the question into a cube with side length 1 to transform the part to the whole. ③ Model Construction: when partially solving the surface area (or volume) of the ball outside the geometric body, closely follow the characteristics of the known length, and put it into the cube (or cuboid) to construct the radius model of the ball.

The above problem-solving teaching, the use of problem strings to inspire students, through analysis and reasoning, guide students to transform the idea of problem-solving, construct the cube model, and summarize the law of finding the radius of the ball[2]. This process is in line with students' cognitive process and reflects the thought of transformation and conversion from part to whole, analyzing the problem from the system, reflecting the occurrence of deep learning, while cultivating students' core literacy of logical reasoning and mathematical operations, and thickening the core literacy of mathematical modeling.

2.3 Reflective problem solving for deep knowledge understanding

Students' problem-solving thinking is implicit, and moderate reflection is required after problem-solving to allow students to think about the problem repeatedly and continuously so that students can develop good study habits and help them achieve a deeper understanding of knowledge. When reflecting on a problem, it is important to have a sense of self-questioning and to reflect in questioning. For example, when teaching a lesson on the existence theorem of zero points, students have mastered and experienced the existence theorem of zero points only as a way to determine whether a function on some open interval has zero points, that is, the theorem is not invertible. Immediately afterward, the teacher asks the question: What types of zero points cannot be determined by this theorem? Make students question and review the reflection, and give the simplest example-the quadratic function corresponds to a graph tangent to the x-axis when the zero points (the horizontal coordinates corresponding to the tangent points) exist, at which point the existence theorem of zero points fails.

After the problem is solved, through reflection, students can clarify the premise of using the zero-point existence theorem, make it clear that the zero-point existence theorem is not infallible in determining the existence of zero points, and improve their cognitive structure through reflection and summarization. For example, in the above example, if the problem of finding the radius of the external sphere of the orthotetrahedron is clear, students can further think about other geometries to find the radius of the external sphere and reflect on these strategic problems after the specific problem is solved, which helps students to form higher-level learning results and thinking structures.

3. Thinking about deep learning

At present, the development of students' core literacy in mathematics is the goal of the mathematics curriculum reform, and deep learning, which is rooted in the development of students' literacy, is bound to become the basic trend of the reform of regular classroom teaching methods. Through deep learning, the students' learning state will advance from fragmentation to systematization; the evaluation of classroom teaching will progress from focusing on the evaluation results to paying deep attention to the process; the stimulation of learning thinking will advance from low-order hovering to high-end progression. Let students experience in deduction, perceive in experience, criticize in perception, innovate in criticism, and finally promote logical reasoning and knowledge construction.

I believe that deep learning should be based on building learning communities as a point of interaction, motivating students to learn as a starting point, focusing on students' nearest development areas, and diversifying assessment methods to help make more effective decisions about teaching and learning reform.

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