Study on Teaching Strategies of Scratch Programming in Elementary Schools based on Deep Learning Theory

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Abstract. Scratch programming software uses block building instead of code input, which effectively reduces the difficulty of programming. This paper discusses how to use deep learning theory to improve the teaching effect of Scratch programming, and proposes some effective Scratch programming teaching strategies based on deep learning, which can provide reference for front-line Scratch programming teachers.

Keywords: Deep Learning; Scratch; Teaching Strategies.

1. Introduction

In the 21st century, programming languages are an important tool leading to the age of artificial intelligence and have become an important part of the IT curriculum in elementary schools. Programming language teaching can promote the development of learners' creative ability, problem solving ability and computational thinking. However, programming languages such as C++, Python and Java are so complex and abstract in structure that is not suitable for primary school students.

Scratch programming is a kind of building block programming, which can present cartoonish running effects and effectively stimulate students' interest in learning programming, making them curious and confident in learning coding. Deep learning emphasizes the necessity for learners to deeply understand knowledge, fully engage in the learning process, actively communicate and cooperate, and develop transfer and problem-solving skills. Integrating deep learning theory into elementary school scratch programming instruction can enable learners to construct programming knowledge structures, promote logical thinking development, and develop problem-solving and innovation skills.

2. The Meaning and Characteristics of Deep Learning

2.1 The Meaning of Deep Learning

In 1976, Ference Marton and Roger Saljo, in their joint article *On Qualitative Differences in Learning: I-Outcome and Process*, first introduced the concepts of Deep Learning and Surface Learning based on the difference in the way learners acquire and process information. While surface learning is mechanical memory-based learning that points to the text symbols themselves, deep learning is learning that points to the meaning contained in the text symbols, comprehensible and associative learning [1]. This statement defines deep learning simply as a way of learning with understanding, which is in contrast to the mechanical memory that corresponds to surface learning. As scholars have studied deep learning cognitive processes, deep learning is understood as the process of applying knowledge to new contexts, i.e., transfer [2]. The Hewlett Foundation responded to the requirements of the times and society for talents by proposing a framework of deep learning competencies, and the connotation of deep learning gradually shifted from cognitive processes to learning outcomes, expanding to various fields such as cognitive, interpersonal and personal competencies [3]. Whether it is the learning style, learning process or learning outcome perspective, the connotations of deep learning are intertwined and inherited, showing some common features.

Deep learning refers to the learning of the meaning of symbols rather than the mechanical learning of the symbols themselves. In the process of learning, learners activate their existing knowledge and experience, analyze the meaning of symbols, and develop critical understanding. This deep understanding enables the learner to grasp the essence of the problem in a new context and to use the knowledge flexibly to solve the problem. At the same time, deep learning is necessarily an active, positive, and fully engaged learning process, characterized by a high level of emotional involvement and motivation. In this process, learners actively communicate and cooperate with others, consciously monitor their own learning process, adjust their learning strategies, and develop learning and interpersonal skills.

Thus, deep learning does not merely describe the level of students' understanding of knowledge, but rather an understanding-based learning process in which learners achieve knowledge construction, thinking ability and competence development. This study defines deep learning as a learning process in which learners are fully engaged in the learning process, critically learn new knowledge, actively construct a knowledge system, and ultimately achieve knowledge transfer and problem solving under the guidance of the teacher.

2.2 The Characteristics of Deep Learning

The characteristics of deep learning are the learners' performance in the learning process and the conditions for determining the occurrence of deep learning. Deep learning, according to the definition of deep learning, is not only concerned with learners' knowledge learning, but also emphasizes metacognitive strategies and the development of interpersonal and problem-solving skills, including the characteristics of understanding and constructing, experiencing and regulating, and transferring and applying.

1) Understanding and Constructing

Knowledge learning is the core of deep learning, while understanding is the foundation of deep learning. Connecting and constructing is the learning mechanism of learners in the process of deep learning, which means deep understanding of knowledge, i.e., internalization of knowledge. Knowledge is not fragmented and isolated points, but can be explained to each other. This is because the subject knowledge itself is systematic and structural, especially the knowledge structure of Scratch programming is more tightly structured, and learners' learning must follow the structural characteristics of knowledge. Deep learning focuses on the integrated construction of knowledge. learners need to generate understanding of knowledge based on their own experience, integrate new knowledge into the existing knowledge system, link old and new knowledge, and form an organized and hierarchical structure system.

2) Experiencing and Regulating

The learner is not a spectator in the deep learning process, but must experience the "re-creation" of knowledge and participate fully in the learning process. The "experiencing" is emotional and interpersonal, meaning that the learner in deep learning is highly motivated and emotionally engaged, willing to explore and actively communicate and collaborate. "Regulating" is metacognitive in nature, meaning that learners consciously monitor the learning process and adjust their learning strategies. Regulation takes place in the individual learner's mind and is autonomous. However, the learning experience is generated in the learning community and is social in nature, which means that the deep learning process is a fusion of personal and humanistic consciousness.

3) Transferring and Applying

Deep learning is ultimately oriented to practical problem solving. Transfer and application are the manifestation of knowledge externalization into ability, and the basic way of problem-solving ability formation. "Understanding and constructing" is the basis for transferring and applying, which means that learners master the essence of knowledge and core concepts, and then realize the ability to learn by example. "Transferring and applying" is the high-level goal of deep learning and the starting point of the next stage of learning. Learners' learning results in this stage are tested through "transfer and application". Through the next stage of learning, the knowledge learned in this stage is integrated with the new knowledge as the existing cognitive structure and transferred to new situations to solve new problems in the next stage.

3. Teaching Strategies for Scratch Programming in Elementary Schools based on Deep Learning

3.1 Activate Learners' Interest and Cognitive Structure through Inspiration and Guidance

According to Piaget's theory of cognitive development, people develop their own unique cognitive structure as they interact with their environment, and this structure includes both life experience and prior knowledge. Learners need to incorporate new knowledge into their existing cognitive structures through both assimilation and adaptation [4]. Scratch programming knowledge is inherently structural, and the knowledge points in the course are closely linked. The programming knowledge involved in each programming task may be embedded in another programming task. Thus, to promote deep learning, teachers should create situations that activate learners' existing cognitive structures. When learners discover that they already have the appropriate knowledge base in their minds, they will have more confidence and interest in the learning task.

For example, in scratch programming, a character switches its shape when it touches the edge of the stage. The implementation of this effect consists of two steps, one is to set "touch the edge of the stage" as the condition, and the other is to set "switch the look" as the result of the condition. Switching the shape is similar to switching the background. If the learner has already mastered the coding skill of switching backgrounds, then he only needs to set the condition to complete the task.

3.2 Help Learners Form a Body of Knowledge through Abstraction and Construction

This is a key part of deep learning and a core part of programming skills development. After presenting the learning task, teachers need to continuously ask focused questions to help learners break down the learning task into multiple subtasks and the master plan into multiple small steps. Through the teacher's guidance, learners are able to analyze the knowledge points contained in each step and form a mind map made up of knowledge points. In this way, the learner is able to develop a more complete programming plan and grasp the logic of the program's inner knowledge. At the same time, learners need to abstract descriptive language into procedural language in this process to deepen their understanding of the task.

This process of abstraction and construction is the process of deep learning and is the basis for problem solving. Abstraction helps learners to grasp the essence of things, hide unnecessary details, and prevent them from being overwhelmed by problems in the subsequent coding process. Constructing, on the other hand, splits a task into relatively independent subtasks and thinks about the knowledge points involved in each subtask to simplify and automate the solution of complex problems. Then, learners combine the knowledge points in the coding process and construct a mind map to form a new schema, or knowledge structure.

Table 1. Scratch Coding Task of Feeding Frenzy

Subtasks	Knowledge Points
Marine Background	Select ocean background image.
Big fish and small fish appear.	Select the big fish character and small fish character, set the size and character display respectively.
The small fish swims freely.	Set the small fish to face a certain direction and repeat the movement.
The big fish swims.	The player manipulates the up, down, left and right buttons to make the x and y coordinates of the big fish character change accordingly.
When this big fish eats the small fish, the small fish disappears and the big fish becomes bigger.	Using the "Touch" block in the detection module and the control module, set the size of the big fish to increase when the big fish touches the small fish, and the small fish to hide for five seconds.
The small fish reappears in a random location.	Using the "Move to..." block in the motion module, set the fish to move to a random position and display after five seconds of hiding.

For example, the coding task of Feeding Frenzy was decomposed to form the task flow and knowledge structure shown in Table 1. In this case, "the big fish swims" is transformed into "the player manipulates the up, down, left and right buttons to make the x and y coordinates of the big fish character change accordingly". By transforming the language, the learners try to abstract the fundamental problem from the complicated information, explore the essence of the problem, and deepen their understanding of the program.

3.3 Integrating Problems and Tasks to Develop Learners' Collaboration and Transfer Skills

This session is where learners engage in cooperative inquiry and work creation, and is a practical part of deep learning. Teachers need to provide corresponding resources according to the task content, such as music and character materials, provide clues for problem solving through interaction, assist learners to complete the game subtasks one by one, encourage learners to innovate on the basis of migration, and finally build a complete game program and form a systematic knowledge system. Through cooperative inquiry and practice, learners' cognitive structures are no longer isolated and scattered knowledge points, but closely connected dynamic schemas. At the same time, learners actively communicate and develop interpersonal skills in the process of cooperation.

In addition, transfer is an important condition for evaluating whether deep learning occurs. Teachers should ask guiding questions, lead learners to apply their knowledge in new contexts, and try to explore multiple problem-solving approaches. For example, in the Feeding Frenzy programming task, the big fish can move as the player manipulates the keyboard, and the big fish can also follow the mouse. This is a much more concise way of coding to achieve a similar effect. Exploring different solutions not only promotes knowledge transfer, but also fosters divergent and creative thinking in learners.

3.4 Develop Learners' Metacognitive Strategies and Critical Thinking through Assessment and Instruction

Finally, the evaluation of deep learning should be carried out throughout the teaching process, playing the role of promoting learning and thinking through evaluation. Deep learning requires learners to develop deep learning abilities, including metacognitive strategies, communication and cooperation skills, migration and problem-solving abilities, on the basis of mastering programming knowledge. Teachers should continuously guide their students to consciously evaluate their own learning progress and attitudes throughout the teaching process. Learners need to regulate their own learning progress, examine the feasibility and rationality of problem solutions in light of the effects presented by the game, and correct procedures that deviate from the goal. For learners, this process is a process of self-monitoring, reflection and regulation, as well as a process of conscious metacognitive monitoring, which can effectively improve learning efficiency. At the same time, learners' interactive motivation and expressive skills should be noticed and evaluated, as these skills are indispensable for success in work and life in the 21st century.

Overall, evaluation of deep learning is diverse, multidimensional and multi-subjective. Teachers and students should combine self-evaluation, peer evaluation and teacher evaluation to examine whether learners have a deep understanding of knowledge, whether they can transfer knowledge, and whether they can solve problems. When evaluating students' work, teachers should take into account the completeness, creativity and knowledge of the work. In this way, the learning effect can be examined comprehensively and objectively.

4. Summary

In Scratch teaching, teachers carefully design the teaching process and choose appropriate teaching strategies based on deep learning theory to enable students to achieve knowledge understanding, construction and transfer. Learners develop higher-order abilities such as metacognitive strategies, logical thinking, migration and interpersonal skills in the process of cooperative inquiry. Such teaching strategies can effectively improve students' innovation consciousness and information literacy, and enhance the overall effectiveness of Scratch programming teaching and learners' learning efficiency.

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