This Paper Discusses the Current Situation and Training Strategies of Primary School Students' Computational Thinking Ability

Haiduan Zhu 1, a, Peng Deng 1,b,*

1 School of Information Science, Yunnan Normal University, Yunnan, 650500;

a 2352757305@qq.com, b yndenken@163.com

Abstract. Computational thinking is the key to cultivating students' core literacy in the information age, and it is also an important entry point to promote the reform of information technology curriculum. Acquiring computational thinking becomes a foundation, and it should be a must-have for everyone, just like reading, writing, and arithmetic. As computational thinking has been widely concerned by the international computer and education circles, the cultivation of computational thinking has become more and more important. At the same time, the cultivation of computational thinking is a long-term and systematic process, so it is necessary to carry out research on the cultivation of computational thinking from the primary school stage. Based on this importance, this paper analyzes the current situation of computational thinking cultivation of primary school students and discusses how to cultivate computational thinking of primary school students based on the current research situation.

Keywords: Computational thinking; Primary school student; Cultivation status; Nurturing strategies.

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1. Introduction

The development of computational thinking can be traced back to the early days of computer science. At the beginning of the 20th century, with the advent of the first electronic computer, people began to use computational thinking to solve various problems. During this period, computational thinking has been embodied in computer science, such as the Turing machine model proposed by the British mathematician Turing, which described the functions of computers in an abstract way and laid the foundation for later computer design and algorithm research. In the 90s of the 20th century, with the popularization of personal computers and the rise of the Internet, computational thinking was more widely used. During this period, people began to use computational thinking to solve various practical problems, such as data mining, image processing, natural language processing, etc. At the same time, Internet-based distributed computing and parallel computing technologies also provide new opportunities for the development of computational thinking. In the 21st century, with the rapid development of big data, artificial intelligence and other technologies, computational thinking has become more and more widely used in various fields. Many educational institutions have begun to realize the importance of computational thinking and have launched relevant courses and activities to improve students' computational thinking skills. The process of computational thinking is closely related to the development of computer science. With the continuous advancement of technology and the continuous expansion of application fields, the cultivation of computational thinking has also received more and more attention. In the future, with the continuous development of technology, the cultivation of computational thinking will become more popular and in-depth.

The definition of the connotation of computational thinking has always been a controversial issue in the academic community. It first appeared internationally in 1980 when Massachusetts Institute of Technology professor Seymour Papert proposed the interdisciplinary value of
computational thinking - thinking and learning with computational thinking [1], which was again illustrated in his research in 1996. But it was Carnegie in the United States that really brought computational thinking into the public eye. Professor Jeannette M. Wing of Melon University (CMU). She proposed that "computational thinking is a series of thinking activities covering the breadth of computer science, such as problem solving, system design, and human behavior understanding, using the basic concepts of computer science". [2] It shows that computational thinking is a process from isolated thinking activities to integrated thinking.

The development of computational thinking has a long history both at home and abroad. Internationally, the United States is one of the most mature countries in the development of computational thinking. The U.S. education system has incorporated computational thinking into teaching at the elementary and middle school levels, and many schools offer programs related to programming and computer science. In China, some progress has also been made in the development of computational thinking. In 2017, the Ministry of Education of China listed computational thinking as one of the core competencies of high school information technology [3], and began to pay attention to cultivating computational thinking among high school students. In 2022, the Ministry of Education incorporated information technology into the national compulsory education curriculum, and computational thinking became one of the core competencies of the information technology curriculum. In short, the development of computational thinking has gone through many stages and has received more and more attention at home and abroad. With the advent of the digital age, the importance of computational thinking will become more prominent, and it will have a profound impact on education and society.

2. The Current Situation of Computational Thinking Cultivation in Primary School Students

In recent years, with the rapid development of various emerging technologies, society has undergone profound changes in the way we work, live and learn. In this highly information-based era, the importance of computing has gradually become prominent, which has attracted attention to the role of computational thinking in information technology education. Computational thinking has become the core concept of computer science and the basic way to solve problems in various scientific and technological fields. It is not only a discipline category, but also an important indicator that reflects the country's future innovation ability and cultivates innovative talents. In the era of knowledge creation as the core, the research and practice of computational thinking cultivation on a global scale continues to flourish and has become an important research topic in the world. Although China has not yet issued a national policy for cultivating computational thinking in primary school students [4], the cultivation of computational thinking has gradually shifted to basic education. Under the guidance of policies, primary schools in China have gradually used programming tools and robotics to cultivate students' computational thinking. For the cultivation of computational thinking in primary schools, according to the analysis of existing network resources, there are mainly the following statuses:

At the social level: Traditional education divides the curriculum into specific disciplines, and subject-based teaching stays at the level of passive learning by students, and students are unable to actively solve complex problems [5]. At present, most of the information technology courses in primary and secondary schools in China are aimed at teaching students to use computers, and in information technology courses, primary school students usually only learn how to operate various technical means [6]. In the end, only the basic skills of computer application are acquired [7], which limits the effective integration of technology and other knowledge, and finally the so-called computational thinking is only superficial, and computational thinking loses its core value as an abstract way to solve problems. In traditional information technology courses, computer application learning based on programming often focuses on students' passive acquisition of technical knowledge, ignores real-life situations, and does not pay attention to the integration of technology
and other disciplines, thus losing its core value of solving complex problems in the real world \[8\], and how to truly cultivate computational thinking has become an urgent problem to be solved in the education field.

For teachers: Many schools focus on teaching computational processes and outcomes in mathematics teaching, while neglecting the cultivation of computational thinking. They often only focus on students' mechanical calculation and memory, and lack the ability to cultivate students' logical thinking and problem-solving. Mathematics classrooms often only stay at the level of concepts and theorems, and lack the teaching of combining mathematical knowledge with practical problems. Primary school students lack the ability to use mathematics to solve real-world problems. Due to the differences in intellectual development and teaching methods, some primary school students show strong memory and calculation skills in the process of calculation, but their thinking skills for problem analysis, planning and solving are relatively weak. Many teachings still use the traditional teaching model, and lack inspirational teaching methods that stimulate students' thinking. This limits the development of students' thinking and the cultivation of creative thinking.

For students: (1) The mathematical foundation of elementary school students is essential for developing their computational thinking. However, many primary school students currently have a relatively weak foundation in mathematics, which is mainly attributed to their lack of flexible thinking and interest in mathematics learning in the learning process. In addition, some students may not have enough awareness of self-learning, which also affects the improvement of their mathematical foundation. (2) Learning attitude plays an important role in the cultivation of computational thinking. However, many primary school students do not have a proper attitude towards mathematical calculations. They may think that the calculation problems are simple and do not require much time to think, and some of the calculation problems can even lead to the answer directly. This contemptuous and careless attitude leads to frequent errors in the calculation process, and in the long run, it is difficult for them to improve their computing ability, which is not conducive to their future learning and development. (3) The cultivation of computational thinking requires a lot of practical opportunities and resources. However, many primary schools are currently deficient in this area. Students rarely have the opportunity to apply the computational thinking knowledge they have learned to real-world problems, which limits the improvement of their computational thinking skills. In addition, some schools may lack relevant educational resources and facilities, which also limits the effectiveness of computational thinking training.

3. Strategies Proposed Based on the Status Quo

With the advancement of computational thinking cultivation and teaching reform, in China, the traditional single-subject teaching mode of primary schools can no longer meet the computational thinking needs of comprehensive ability (such as problem-solving ability) in the current era of knowledge economy, and the situation of students' passive acceptance of knowledge needs to be changed urgently. The current situation is that computational thinking is generally cultivated in the IT curriculum, but the traditional IT curriculum in primary schools is more biased towards computer applications, ignoring the importance of real-life situations and not paying attention to the integration of technology with other subject content. This situation has led to the loss of the core value of computational thinking in solving complex problems \[9\]. According to the current situation of the cultivation of computational thinking of primary school students, the following strategies are proposed:

3.1 Interdisciplinary integration

Interdisciplinary education has begun to receive attention and attention in China in recent years. The Ministry of Education promulgated the "Compulsory Education Curriculum Plan and Curriculum Standards (2022 Edition)" to propose "interdisciplinary theme learning", which highlights the importance of interdisciplinary education. \[10\] As a representative of interdisciplinary
education, STEAM education organically integrates knowledge from the five academic fields of science, technology, engineering, arts, and mathematics to cultivate interdisciplinary thinking, problem-solving skills, and creativity \[11\]. Given the interdisciplinary nature of computational thinking, STEAM is also a proxy for interdisciplinary education, and there is a natural connection between the two. As early as 2015, some scholars suggested that the cultivation of computational thinking should be introduced into the STEAM curriculum \[12\]. However, how to organically combine the two is still a major challenge, and the cultivation of computational thinking in existing STEAM education is often limited to programming, and the cultivation of computational thinking is essentially a discipline rather than interdisciplinary \[13\]. However, the traditional curriculum divides various disciplines, and the cultivation of students' computational thinking is mainly concentrated in the information technology course, which is relatively limited to the cultivation of computational thinking, and the cultivation of computational thinking is a multidisciplinary and long-term process.

3.2 Improvement of Teachers' literacy

Computational thinking relies on the discipline of information technology, and the knowledge of information technology also needs to be professional, teachers need to have relevant knowledge and skills, and appropriate teaching resources and support are needed to effectively cultivate computational thinking. Expose students to a variety of different types and difficulty problems in the classroom, leading them to develop computational thinking through analysis, reasoning, and problem-solving. Create a learning environment conducive to students' active examination and interactive cooperation, encourage students to ask questions, try to solve problems, and give timely guidance and feedback. Combining interdisciplinary knowledge with practical application, students can understand the application of mathematics in daily life and various disciplines, and stimulate students' interest and motivation in knowledge. Guide students to carry out logical thinking training, cultivate students' problem-solving ability and creative thinking. At the same time, the education system needs to be reformed to ensure that the development of computational thinking is adequately valued and supported. Updating course materials: Emphasizing the cultivation of computational thinking, incorporating the methods, principles and strategies of computational thinking into the curriculum content, and designing teaching materials that are inspiring and practically applicable.

3.3 External Force Assist

According to Piaget's theory of stages of cognitive development, the cognitive development level of students in primary school is mainly in the pre-arithmetic stage and the concrete arithmetic stage. The development of students' thinking is at a critical stage, and the computational thinking of primary school students at this stage is of great value to the demand for talents in the information society. They need to be exposed to a variety of mathematical concepts such as simple addition and subtraction, shapes, sizes, etc., and understand these concepts through play and practice. For example, use stories, games, or visualization tools to teach basic arithmetic concepts. Students in the concrete operation stage begin to perform logical reasoning and operations, but they are mainly carried out in concrete situations and are not yet able to carry out abstract thinking. At this stage, they can perform more complex math operations such as addition, subtraction, multiplication, and division, but often rely on concrete objects or shapes to help them understand and solve problems. Computational thinking lessons and activities for elementary school students need to be designed to be fun and interactive to capture their interest and keep their attention. At the same time, the activity needs to be age-appropriate and not too abstract or complex, but should help them understand and structure knowledge in a concrete, visible way. The development of computational thinking skills in elementary school students can be effectively promoted through the use of gamified learning, storytelling, role-playing, and other innovative methods.
4. Conclusion

Based on the above analysis, it can be seen that the cultivation of computational thinking in primary school students is mainly carried out in information technology courses, and primary school students only learn how to operate technology, but will not solve real problems, which violates the original intention of computational thinking training, and should break the traditional teaching method, integrate with interdisciplinary concepts, and cultivate students' problem-solving ability in multidisciplinary teaching. In the face of the particularity of primary school students' development, teachers should adopt appropriate methods for students' development. For the cultivation of computational thinking, in the long run, with the advancement of technology, consider combining AI, machine learning or neural network technology to further improve the intelligence and adaptability of the computational thinking training mode. In the future, we can explore how to integrate computational thinking with more disciplines such as language or social sciences to form a comprehensive learning tool.

References