Educational Research Based on the Nature of Computational Thinking

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Abstract. The cultivation of computing thinking is not a requirement of computer science, but the important part of the University's general education. Thinking is not subject to professional restrictions, students with different backgrounds in the professional perspective of thinking, problem-solving methods, and methods of dealing with issues such as commonalities. The popularity and development of computer science make the connection between itself and each specialty more and more closely. The interdisciplinary network research with computer science as the center is gradually forming. Based on the peculiar nature of computational thinking, this paper can explain the proof and the related world, and discuss the relationship between computational thinking and other disciplines.

Introduction

A thinking model is actually a way of looking at the world and understanding of the world view, which is what we call the world view, the core content of the conclusions of the correctness of the judgments of the criteria for thinking. Any thinking is to produce a conclusion as the goal, for the conclusion of the judging criteria, constitute a unique mode of thinking characteristics.

Computational thinking is a thinking mode in which human beings participate in the process of thinking and solve problems and solve them. In this way, information processing can be carried out quickly and effectively, and the solution to the problem is proposed[1]. As expected, procedural thinking (i.e., "thinking like a computer") is considered to be part of the overall thinking skill[2]. Until 2006, Jeanette Wing in the ACM American computer society communication published "Computational Thinking". This article, since then, the calculation of thinking has been a new definition. Wing's article suggests that computational thinking is not only a useful skill for experts in computer science, but a mental process that anyone can use to solve problems and discover computational solutions. In this broader sense, considered as part of logical thinking, computational thinking can be seen as a skill related to all disciplines, not just computer science. Therefore, Wing argued: “to reading, writing and arithmetic, we should add computational thinking to every child’s analytical ability”[3].

Denning suggests whether computational thinking per se is an aspect, problem, or extension of scientific inquiry that could, in fact, be incorporated into the broader architectural framework of scientific principles. Computational thinking appears in other sciences, not as a fluid concept, but because of its own traits. His point of view shows that the popularization of computing in the physical sciences actually means "computing is an infinite
game" and that "computational thinking is more important" and computational thinking than computer science (and scientific computing in a wider field) as a tool has a broader vision.[4]

Computational thinking’s Characteristics

In Zhou's view, the most essential feature of computational thinking is abstraction and automation, and its forms of expression are limited, procedural, mechanical, and feasible. In fact, the abstraction itself is also a feature of mathematics, mathematics itself also recognizes the constructability, can be realized, loop iteration such object generation. Therefore, only from these aspects to elaborate the characteristics of computational thinking, although the grasp of the nature, but the lack of a certain theoretical basis and characterization, it seems not enough to computer science from mathematics, so we need to explore the calculation behind the more essential thinking The content and completely different from the empirical thinking and logical thinking characteristics.

The computer science system also has its basic assumptions, which constitute the cornerstone of computer science. In this paper, we propose three important cornerstones of computer science, as flow: Turing machine theory; feasible computability; Iterative computability.

According to the three important cornerstones of computer science, we make the following interpretation of the nature of computational thinking.

The Nature of Computational Thinking—Explainable Proof

The interactive system emphasizes the solution of the problem is realized in the interaction process, this idea is well reflected in the project. Whether in software development, system design and problem solving, we cannot expect a one-time mathematical solution to all problems, or a one-time proof of the correctness of the software or system. In the vast majority of cases, this mathematical proof does not exist. Therefore, in the actual project, we require the development of software, or design of the system for the control object or the operating environment has a good response, that is, when the control object and the operating environment changes, the control system or operating system can respond in a timely manner, to ensure that the system can run correctly. An interactive system is more suitable as a theoretical basis for describing such engineering problems, rather than as mathematics. In the engineering context, the importance of the system for environmental change responsiveness and adaptability, this problem with the traditional view of mathematics is basically not feasible, so the theory and application of interactive proof can solve this type of problem. In this sense, what we call a software correctness, a system of correctness should be in the interactive proof of the sense of correctness.

Interactions and interactive proofs are the awareness that we should focus on training in computer courses, which was not enough. Due to the profound impact of mathematics, many of the courses in the computer, are often accustomed to using mathematical ideas and standards to solve problems and design systems, these methods in many engineering problems on the poor results. The reason, or because computer science or computer engineering and mathematics are two different ways of thinking, using mathematical thinking way to solve engineering problems will make our ideas too narrow and absolute, it is difficult to cultivate a real computer science and engineering applications Talent. At the other extreme, engineering problems are difficult to be evaluated mathematically. Therefore, in the design and development of many engineering problems, there is no theoretical guidance at all. In this
The quality of the software or the product there is no strict guarantee. Of these cases now exist; the latter seems more common, so a suitable choice is the interactive proof system theory into engineering design and development. This is a kind of thinking that is different from logical thinking, and is one of the problems that we should pay attention to the reform of computer curriculum.

The Nature of Computational Thinking—The Association of world

Another feature of computational thinking is the association. This is a way of thinking about the world from a computational perspective. The world view of physics is causal, for example, when an object changes the form of motion, it must be subject to a certain force. The mathematical way of looking at the world is logical, for example, if from the apex of the isosceles triangle to the bottom to make a vertical line, the vertical line must be divided equally bottom. This is physics and mathematics look at the world in different ways; that is, the world of physics and mathematics [5]. Especially now has entered the era of large data, on data and data, that is, the phenomenon and the relationship between the phenomenon of the study has become an important part of computer science. These studies also promote the rich connotations of computational thinking, that is, the formation of a new worldview of the world from the perspective of association. There are two main types of relationship: one is the spatial relation, the other is the temporal relation, and the other is the relation between the phenomena. In order to find out the location association or time correlation from a large number of phenomena or data, some techniques have been developed to mine these associations. Which on the spatial association, where the space contains both the commonly referred to the geometric space, but also contains the problem of the definition of the abstract space, mainly for the classification of data in the definition of space inside the similar data is divided, or find out Data. With regard to time correlation, the more common is the Bayesian network and through the Bayesian formula evolved out of a variety of dynamic models. Through the correction of the model, we get the order (time) relationship between the data which is close to the real situation [6].

From primary school to secondary school, all of our thinking training is basically causal or logical, that is, physics and mathematics courses for our impact is too deep, and thus to develop a way of thinking that either. However, the calculation of thinking is to train us another way of thinking, this way of thinking concerned about the relationship between things, and the resulting qualitative or even quantitative analysis, this relationship has some uncertainty and variability, which kind of thinking to broaden the perspective of the world and methods. This is the basis for solving problems using computers. Large data analysis and network science is now introduced a large number of related theory and analysis tools. Such as the scale-free theory in the network, the theory of small-world and the power-law phenomenon in the analysis of human behavior are all important rules in association analysis. Thinking from the relationship of things to think about the problem, rather than from the perspective of causal or logical thinking, is the unique nature of the calculation of thinking, as a computer basic course, training this thinking is an important element.

The Integration of Computational Thinking Traits and Disciplines

Based on the interpretability of computational thinking, Roberts et al. developed a cross-training approach to computational thinking and the natural and social sciences [7]. Curzon Proposed that “the most beautiful calculation is engineering, science, art; it has no
clear boundaries and involves every discipline.” This interdisciplinary approach gives us the opportunity to increase students' interests beyond computers [8]. Through the computer and non-computer science cross-culture between the students to improve the calculation of thinking, the calculation of this idea combined with the professional to promote professional learning.

The Integration of Computing Thinking and STEM Fields

In the university education, the practical teaching research on computational thinking is mainly in the field of science, technology, engineering and mathematics (STEM). There are many overlapping concepts between computer science and biology. It is noteworthy that, from the perspective of computational thinking, the intersection of the two disciplines appears in the "traditional" (based on Turing) concept, such as the concept of neural networks. They advocate a further integration of the two disciplines, will improve the understanding of biological evolution, but also improve the design of various algorithms. Despite the interdisciplinary relationship, it says: "While most biology students express an interest in improving their computer skills, in practice they rarely choose computer courses." However, due to various factors, such as students in learning more computer technology does not meet, such as Linux, as well as computer laboratory design in the emergence of the computer information technology, Various issues indicate the need for further reform of teaching environments and methods [9].

In physics, Caballero, Kohlmyer and Schatz use the VPython programming environment to introduce computational thinking concepts to introduce mechanics teaching. They found that "after solving a series of computational problems, most of the students were able to successfully create a new problem" [10]. In these cases, students may not be able to build a successful model, but through the quality of analysis and debugging skills, additional attention, performance will be improved.

Hambrusch studied and created a science rather than a specific field of thinking of major courses in computing [11] This course meets the general computing requirements of applying programming and computational thinking concepts to problems in physics, biology, and statistics.

The above description of the characteristics of computing thinking in the field of cross-STEM and application of computing thinking embodies the scalability.

Computational Thinking and Non-STEM Integration

Based on the relevance of computational thinking, some research institutions use computational thinking theory for literary research. For example, Stanford University literary laboratory, the elements of the calculation of thinking applied to literary works, from the use of computational thinking to learn from the application of graph theory on William Shakespeare, A Dream of Red Mansions and other works in the character relationships and interactions of network analysis [12].

However, the problem of the composition of the humanities using the "traditional" algorithm (Turing) may be difficult to solve. There are cases in which it is difficult to use analytical techniques in the humanities, since its meaning may be simplified. Humanity is committed to interpretation, as the concept of knowledge to understand the phenomenon of social, cultural world, through the idea and formulation of behavior, there is no mechanical or naturalistic representation of pre-existing, clear information. For example, natural language understanding has always been the focus of computer science research topics, which involves
the semantic network, ontology mapping and so on are computer science research areas. Nevertheless, there are still some algorithms in the humanities and social sciences. For example, in the field of political science, Frohock observes that the linear and rule-based nature of algorithmic thinking may become a necessary condition for a pluralistic society[13]. Turkle and Papert point out the impact of purely formalistic computational models, and they further suggest that in addition to the computational problem approach, it may also be reinforced by social assumptions about student gender and ways of thinking.

In the area of music performance, Edwards suggests that music can be synthesized with computer [14]. He applied the computer to the musical works of the mid-twentieth century, the use of computer programs to shape part of the human voice and music synthesis, and this application confirms the effectiveness of synthetic music algorithm is the perfect embodiment of human-computer collaboration. Therefore, the computer as a tool to expand the composer's ability to explore musical inspiration. We believe that the combination of uncertainty and computational thinking in human emotional thinking increases the creativity and expansiveness of people, while computational thinking drives the development of new models of interactive computing.

The calculation of thinking into the field of humanities and arts major courses, the need to introduce the appropriate calculation of the principle of thinking. Introduce computer science courses for students who are not technical majors in order to be more responsive to discipline development. Cortina pointed out that "non-technical non-professional rigor and detail require the correct preparation of computer programs is essential." In this regard, he proposed to develop a new curriculum as an alternative course of programming entry.

Conclusion

Incorporating computational thinking skills into university curricula, the focus is on the instructional design process for analysis and design rather than development and implementation. Instructional designers regard computational thinking as equivalent to other thinking skills; therefore, the strategies they use to design thinking courses are similar to those used in teaching. Therefore, we need more research, the establishment of computing thinking and teaching design and technology convergence better and more specific teaching design strategy.

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References
