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The Application of Bebras Tasks in Primary School Information Technology Curriculum——Based on the perspective of computational thinking assessment

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ABSTRACT

This paper takes the computational thinking assessment as the perspective, quotes the Bebras tasks to the primary school information technology education in China, and discusses its applicability to measuring the computational thinking ability of primary school students in China. 80 primary grade five students are selected as the research sample to prepare "elementary school computational thinking ability test volume" for data collection in the calendar year Bebras tasks coding. As a result, "Bebras tasks" compiled "computational thinking ability test volume" has good structure validity and reliability, suitable for measuring the primary school students computational thinking ability level, therefore, this study puts forward an applicable evaluation method, meanwhile, obviously proving that there is high demanding to cultivate and improve the computational thinking level of current primary school students.

KEYWORDS

Computational thinking; Bebras; Information technology; Evaluation

1 Introduction

Computational thinking is the core competence of students in the 21st century. It is as important as basic skills such as reading, writing, and arithmetic, as well as a vital part of students' core literacy, which determines the level of innovation competitiveness [1]. In the 2017 new edition of Information Technology Curriculum Standards for Ordinary High Schools, the core literacy of information technology discipline includes four core elements, including information awareness, computational thinking, digital learning and innovation, and information social responsibility[2]. Among them, computational thinking is not only the starting point of cultivating students' core literacy of information technology discipline, but also the key element of connecting the basic operation and thinking activities, regarded as the focal point of cultivating the core literacy of information technology[3]. Ren Youqun et al. pointed out that the information technology education and curriculum in primary and secondary schools should fit the mission required by the times and undertake significant task of cultivating students' computational thinking[4].

The computational thinking development has been adopted in the middle school curriculum in many European countries, not alone for the primary education[5], the Ministry of Education pointed out that "computer education in primary and secondary schools focus on information technology, should cultivate students information consciousness and computational thinking"[6], with more fierce competition in artificial intelligence skills, it is particularly important to cultivate students computational thinking ability since young [7]. Scientific and effective evaluation of the core literacy of subjects is not only the inevitable path for the transformation of traditional teaching evaluation but also the proper choice of teaching evaluation in the era of core literacy[8], which is the yardstick to consider the teaching objectives. As one of the core qualities of the information technology disciplines, scientific evaluation is crucial to developing computational thinking and is the basis for cultivating students' computational thinking ability[9]. However, the current domestic computational thinking research is still in the primary stage, the applied research level is mainly concentrated in the higher education stage, lacking the attention to the computational thinking evaluation [10]. This study takes the evaluation of computational thinking as the perspective, quotes the Bebras tasks to the educational situation in China, and discusses its effectiveness and applicability to the measurement of computational thinking ability of primary school students in China, aiming to provide some reference for the cultivation and evaluation of computational thinking of primary school students in China.

2 Computational thinking and the bebras tasks

The word "computational thinking" was firstly proposed by Jeannette M. Wing and brought to the forefront in the field of computer science education in 2006, which is the basis of computer science concept solving, system design, and human behavior understanding covering the breadth of computer science of a series of thinking activity[11]. But the definition of the word "breadth" is not conducive to operation, the 2011 International Education Technology Institute (ISTE) and Computer Science Teachers Association (CSTA) formulated the operational definition of computational thinking, considered computational thinking (CT) as the process of solving the problem of a series of thinking activity[12]. In 2013, the world's leading computer research in the field the University of Southampton, two scholars named as John Woollard and Cynthia C. Selby reviewed the relevant literature since 2006, extracting the consensus or a clear definition of five keywords: abstraction, decomposition, algorithmic design, evaluation, and generalization, proposed that computational thinking was a centralized solution method, containing the abstraction, decomposition, algorithmic design, evaluation, and generalization a series of thinking process[13], the emergence of the definition for the measurement of computational thinking ability provided a reference. British school computational working group (computational At School, CAS) noted in a document "computational progress evaluation framework (computational Progression Pathways)" containing the initials of computational thinking concept, AL (algorithmic design), DE (decomposition), GE (generalization), AB (abstraction), EV (evaluation), which could be used as a specific index of computational thinking measurement[14].

The International Computational Thinking Challenge (Bebras) aims to promote computational thinking[15] among students of all ages. Besides China, more and more countries around the world have joined the competition. The International Computational Thinking Challenge sets all tasks related to computational thinking. Bebras adopts the "computational thinking evaluation framework" proposed by CAS. Each task will correspond to one or more of the five dimensions of computational thinking. Due to the fact that students at different age in eachlevel of education school are able to solve tasks at different level of content and difficulty coefficient. Bebras divides the difficulty of all tasks into three levels: A, B, and C, and steps from A-C difficulty, making it more targeted and applicable. Table 1 is an example of a task of "C" in Bebras (2018) (primary school). It can be found that this task mainly corresponds to the computational thinking ability of algorithmic design and evaluation. International relevant empirical studies show that Bebras tasks can be used as one of the primary school students[16]. However, no evident Chinese literature related to "Bebras" was found, when it was selected as theme or keyword in the CNKI (cnki) database. Therefore, the researchers took Bebras calendar year tasks as the source of the test questions compiling the "primary school computational thinking ability test paper" toverify the applicability of Bebras tasks to the evaluation of primary school computational thinking in China and provide a new reference perspective for the evaluation of primary school computational thinking in China.

Table 1 Bebras task example——elevator

Bebras Task description	age group	Computational thinking elements	degree of difficulty
There are 9 beavers of various weights to take two elevators, and each elevator can only accommodate 30kg at most, to try to get as many beavers can take the elevator at a time, how to combine it?	Age 8-10	algorithmic design (AL), Evaluation (EV)	C

3 Research design

In this study, two classes were selected in a primary school in Chongqing, classified as Class A and Class B, with 40 students. According to the connotation of computational thinking factor, abstraction, decomposition, algorithmic design, evaluation, and generalization of five dimensions, the international computational thinking contest in 2014-2018 was selected, then translated into Chinese. Finally, 8 was selected as the topic of age group and refined extracting 12 topics containing correct part of the topic, compiled the test volume, test volume coding diagram (figure 1).

Each Bebras task will match the computational thinking five factors (abstraction, decomposition, algorithmic design, evaluation, and generalization) of one or more labels (table 2), which reflects 4 questions of abstraction dimensions, 4 questions of decomposition dimensions, 5 questions of algorithmic design dimensions, 4 questions of generalization dimensions and 5 questions of generalization dimensions., because the test volume single topic may correspond to multiple dimensions of computational thinking, each dimension corresponds to the total number of differences, so that this study mainly analyzes the students computational thinking overall ability level.

Table 2 Corresponding relationship between test questions and computational thinking

Question number	abstraction (AB)	decomposition (DE)	algorithmic design (AL)	generalization (GE)	evaluation (EV)
1			√		√
2		√			√
3	√	√		√	√
4			√		
5					√
6	√	√		√	
7			√		
8	√				
9			√		
10		√		√	
11	√			√	
12			√		√

The researchers used the computational thinking ability test paper to evaluate 80 students in Class A and Class B, and 40 test papers were issued to each class. The 100-point system and the class timing test took 40 minutes, and the effective recovery rate of the test papers in both classes was

100%.

4 Data analysis

4.1 Credit and validity test

The collected data is entered into SPSS, and further coded, 1 is correct and 0 is incorrect, the Cronbach alpha reliability coefficient of abstraction, decomposition, algorithmic design, generalization, and evaluation is calculated respectively: 0.799, 0.740, 0, 0.777, 0.724 and 0.858. The overall reliability value of the test volume is 0.881, and the five dimensions are in a good range, indicating that the test volume has high reliability and can be used as a formal test volume (Table 2). The structural validity of the test volume, and the test results are shown in Table 3, the KMO value is 0.780, indicating that there is a common factor, the test volume has good structural validity, suitable for factor analysis, Sig value is 0, less than 0.05, which is also suitable for factor analysis.

Table 3 Reliability statistics

Measuring dimensions	Clone Bach, Alpha	number of terms
abstraction	.799	4
decomposition	.740	4
algorithmic design	.777	5
generalization	.724	4
evaluation	.858	5
Overall reliability coefficient	.881	12

Table 4 KMO and Bartlett tests

Several KMO sampling suitability quantities.		.780
Bartlett sphericity test	Approximate chi-square	350.535
	free degree	153
	significance	.000

4.2 Computational thinking "five elements of" achievement analysis

Comparing class A and class B evaluation data through the SPSS, analysis of the average score, class A and class B 36.62 and 37.92 respectively (table 4), the analysis of computational thinking "five elements" abstraction, decomposition, algorithmic design, generalization, and evaluation mean is less than 60, from the total score and the average score of five dimensions. There are larger training space for the two class students in the overall thinking level of five dimensions .

It can be concluded that two classes students computational thinking "five elements" development level is unbalanced after the analysis of the distribution of the "five elements" computational thinking score, the evaluation ability and generalization ability of score difference, for the above three values, they turned out to be 52.33, 25.06 and 27.27 in class A respectively, while 58.00, 26.59 and 31.41 in class B. Among them, the score of generalization ability and evaluation ability is closer to 60, while the score of the three elements of abstraction, decomposition, and algorithmic design is far from it，which obviously show abstraction, decomposition, and algorithmic design are the focus of cultivating primary school students' computational abilities.

Table 5 Group statistics

	classes and grades in school	The number of cases	average value	standard deviations	Standard mean
total points	Class A	40	36.6207	13.66558	2.16072
	Class B	40	37.9270	14.48097	2.28964
abstraction	Class A	40	33.1944	9.86515	1.55982
	Class B	40	35.2500	11.22728	1.77519
decomposition	Class A	40	25.0683	8.18294	1.29384
	Class B	40	26.5906	9.80544	1.55038
algorithmic design	Class A	40	27.5077	10.29977	1.62854
	Class B	40	28.5448	11.56440	1.82849
generalization	Class A	40	45.0000	18.54718	3.88125
	Class B	40	41.2500	16.88413	4.25075
evaluation	Class A	40	52.3333	13.73332	2.17143
	Class B	40	58.0000	14.36599	2.27146

5 Conclusions and outlook

In this study, the Bebras tasks were used to evaluate the computational thinking of primary school students, and the reliability and validity of the "primary school computational thinking ability test paper" composed of Bebras tasks coding was tested. The results show that the test is reliable and valid and is suitable for measuring the computational thinking ability of primary school students in China. Therefore, this study provides an applicable evaluation method for the evaluation of computational thinking of primary school students in China. According to the analysis results of sample data, there is still much room for cultivation and improvement of the computational thinking level of primary school students, and the distribution level of ability in various dimensions is unbalanced.

It is also further explored the applicability of the Bebras tasks for students' computational thinking measurement in other stages of k12, to broaden the application value of the Bebras tasks in teaching. This study is the evaluation of computational thinking as a perspective, used in primary school information technology as the curriculum carrier, as wellas some interdisciplinary integration learning task, which can be integrated with elementary school mathematics or science discipline, and broaden the space of computational thinking to cultivate, lay the foundation for the subsequent formal programming course, especially before the student's formal contact programming. It is undoubtedly both a major challenge to truly integrate computational thinking into the current primary and secondary school curriculum and a compulsory implemention in gradual process, which requires the joint efforts of a wider range of educators.

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