Computational Thinking (CT) Among University Students

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Abstract—Computational Thinking (CT) is very useful in the process of solving everyday problems for undergraduates. In terms of content, computational thinking involves solving problems, studying data patterns, deconstructing problems using algorithms and procedures, doing simulations, computer modeling, and reasoning about abstract things. However, there is a lack of studies dealing with it and its skills that can be developed and utilized in the field of information and technology used in learning and teaching. The descriptive research method was used, and a test research tool was prepared to measure the level of (CT) consisting of (24) items of the type of multiple-choice to measure the level of "CT". The research study group consists of (100) third-year students studying at the University of Baghdad in Computer Science within the scope of (2020–2021). The results are detailed.

Keywords—Computational Thinking (CT), university student, smart technologies, online learning

1 Introduction

Building creative and intellectual minds that take their societies to revolution and technological and scientific progress, form the pillars of what countries and societies aspire to, which aims at progress and technological progress. Hence the urgent necessity for intellectual progress along with technological progress [1]. CT in its contemporary sense emerged in the year 2006, and as such, it is among the most recent contemporary trends. Despite widespread interest in it, literature has proven that its skills are not well taught [2, 3], with the focus being on teaching students how to deal with technologies only, rather than thinking about developing and inventing new ones. Thus most students still use the technology in one form or another, not its developers [4, 5]. It is the new literacy of the twenty-first century and is considered an essential skill for everyone, not just computer scientists. It's a thinking process involved in formulating problems and their solutions so that the solution is effectively presented that can be implemented by an information processing agent [6–8]. It is prepared as a set of cognitive processes such as abstraction, decomposition, generalization, mathematical reasoning, and evaluation [9, 10]. The "CT" that students appear when creating or

executing a series of steps is to achieve the desired result. The analysis breaks down a complex problem into elements and then works on one element at a time. Abstraction is the removal of unimportant details to arrive at a general solution or representation of a complex system with a simple or conceptual model. Distinguishing patterns by analyzing the trend of data and using that information to develop solutions, all of which are computational thinking skills [11, 12]. Computational thinking is also intricately linked to critical thinking and STEM learning [13, 14].

2 Computational Thinking (CT)

Thinking is a cognitive system that deals mainly with meanings, concepts, and perceptions, depending on the use of symbols that represent mental processes, whether through direct or symbolic expression [15]. Formulate issues such as those where computers might help. Identify, test, and implement possible solutions. Automate solutions through computational thinking. Generalize this process and apply it to other topics. So it is a framework for describing a set of problem-solving skills. It is metacognitive thinking in dealing with life's problems [16–18]. Procedurally, researchers define it as "the ability of the sample students to respond to the items of a computational reasoning test, as measured by the overall score they will receive." CT appeared in the fifties; sixties of the last century, and means the orientation of the mind to formulate problems as transformations and to search for algorithms to perform these transformations. It was developed to include thinking at high levels of abstraction, using mathematics to develop algorithms, and finding the best solutions to different problems [19, 20]. The term computational thinking was first used by [9], and it is considered a problem-solving method that uses computer science techniques. Computing has been described as a method for solving problems. Living in a world steeped in technology, everyday non-digital subjects are often designed to work via computer programs such as street lights, clocks, roads, and even simple boxes [13, 21]; so we need to think mathematically. Thriving in today's world requires "CT" to be an essential part of the way people think and understand the world around them [22–26]. The core of "CT" is an abstraction. It is a type of analytical thinking and shares with "MT" the general ways in which we might approach the solution of a problem. Computed tomography is not limited to computer programming. Also with "ET" about the general ways in which we can design and evaluate a large and complex system that operates within the constraints of the real world. It also shares with "ST" the general ways in which we may approach the understanding of computing, intelligence, human reason, and behavior. Therefore, it is not limited to computer programming only but involves visualizing problems in abstract ways that combine mathematics and engineering and is already used in all professions [27–30].

The mind can formulate problems and solutions so they can be visualized as algorithms. It is a basic set of cognitive skills suggested for everyone, not just computer scientists. It is a problem-solving process in which the problem that requires the use of technology to solve is formulated, data analysis, abstraction i.e. data representation, models and simulations, automation algorithms, software improvement through quality measures, generalization [31–33]. That "CT" draws on mathematics as its foundation

and, therefore, is the latest cited attempt to bridge the gap between computer programming, mathematics, and other fields to facilitate problem-solving [28]. The most prominent definition of CT is the procedural definition provided by the (CSTA) in collaboration with the (ISTE). It describes CT as a problem-solving process and includes:

1. Formulate problems so that a computer can be used to solve them.
2. Organize and analyze data logically.
3. Data representation through modeling and simulation.
4. Automation of solutions.
5. Identity, analyze, implement available solutions.
6. Generalization.

In terms of content, it includes problem-solving, studying data patterns, deconstructing problems using algorithms and procedures, measuring simulation, computer modeling, and thinking about abstract things [34].

The features are as follows:

1. Focusing on concepts, not programming.
2. It is a major skill, not a routine.
3. It is humans think way, not a computer thinks.
4. CT" complements and includes mathematical and engineering thinking.
5. CT is useful for anyone, anywhere.

CT is the process of solving a problem; typically categorized for pattern recognition, abstraction, algorithm design, and analysis which has the following characteristics:

1. Analyzing and organizing data logically.
2. Data Modeling, Data Abstraction, and Simulation.
3. Formulating issues such as those in which computers may help.
4. Identifying, selecting, implementing solutions to the problem.
5. Automating solutions through algorithmic thinking.
6. Generalize this process and apply it to other issues.

Learning CT can benefit students both academically and economically, the ability to solve problems, improve student engagement and communication within TLEs, and learn and perform STEM.

3 Methodology

A descriptive research method was adopted. The research community was all students/Computer Science/College of Education/"University of Baghdad" for the academic year (2021–2022). The research sample was randomly selected (100) male and female students from the third stage. In this research, the main terms, namely "CT". Additionally, the term namely "university students", was also checked.

The two research null hypotheses are:

1-There are no statistically significant differences at the significance level "(0.05) between the average real performance"; the "hypothetical average performance of students in the sample research in (CT) test.

2-There is no "statistically" "significant" "difference" at "significance level" (0.05) between mean s of male; female students in the research sample on the (CT) test".

To build a test to measure the level of "CT" consisting of (24) items of objective paragraphs and computerized it by visual basic (V.B.) in its final form. First of all; specify the purpose of formulating the paragraphs of the CT test, then determine the fields of computer thinking. In light of the fields, test items were formulated and then presented to a group of experts and specialists in education, psychology, mathematics, methods of teaching them, and instructors of the computer science dep. to demonstrate their observations on the validity of fields; paragraphs. The apparent validity of the test and suitability of each item to research requirements were confirmed Unanimously approved by (80%) of the experts, and finally, the test is ready to be applied to the exploratory sample. The test was applied to a selected "sample" of the research community consisting of (30) male and female students. To know the clarity of the paragraphs, clarity of the answer instructions, and to calculate the time which was (45) accurate enough. Then after correcting the test conducting statistical analysis of the paragraphs and confirming the psychometric properties (the discriminatory strength of the paragraphs, the coefficients of difficulty and ease of the paragraphs, the validity, including the apparent validity, construct validity, and consistency). The test was ready to be programmed and its final application. It was programmed by the Visual Programming Language (V.B.) to become an electronic test; so that every student enrolled in the department of computer science or other scientific departments in the same College can easily apply it and measure the level of his "CT". It is a language with a visual design with a graphical interface. It contains many commands within it, and depends on the development of its applications on objects, as it is similar to almost languages of programming; its dependence on dynamics; events. Dynamic is the ability to invoke either association or procedure based on "event"; and the event is an operation that the user of the application performs on the application, such as pressing the mouse button, pressing one of the keyboard buttons, or even downloading a form. It is an easy language to apply, based on HTML, which makes it easy to understand and use.

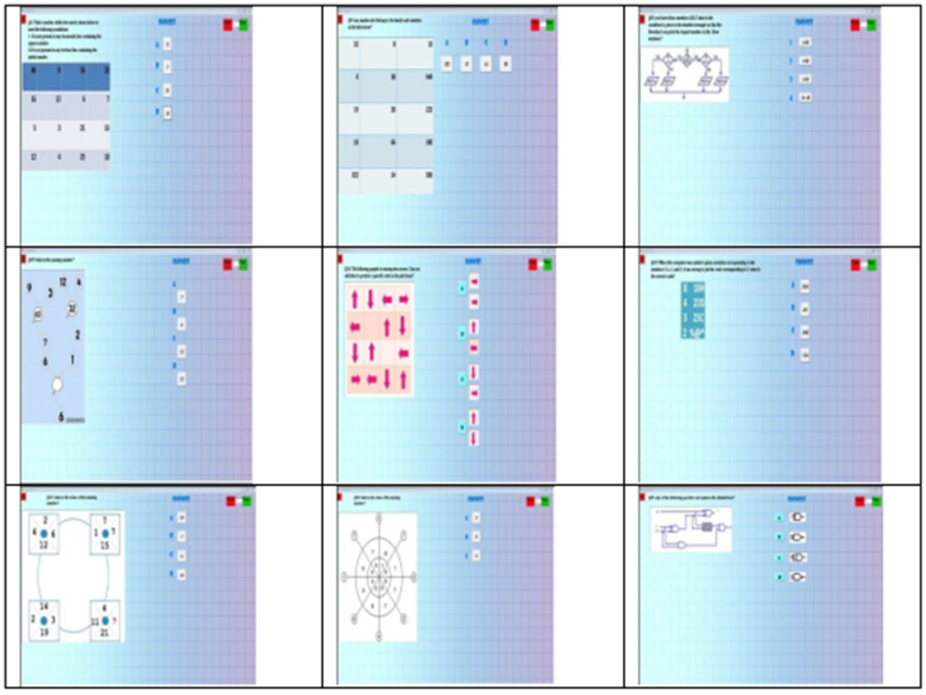

Fig. 1. Some paragraphs of the CT test

4 Results and discussion

We found all test items have a mean higher than the hypothetical average, by observing the arithmetic average of the scores obtained by the students of the sample on the test. It is meaning that the sample students have (CT). So for the null hypothesis no. 1. Also by comparing the arithmetic mean with the hypothetical average meaning accept the alternative hypothesis and reject the null, thus, the sample students have "CT". The reason may be all students are accepted into the computer department based on the degree of differentiation in mathematics, and this means that they have logical and Algorithmic thinking thus computerized; in addition to as a result of the academic effort made with them during their years of study through a good interest in students 'academic preparation programs. It is noticed that the t-test value calculated is higher than the "tabular", which means rejection of "null hypothesis" and acceptance of the alternative. Meaning that there is a difference between the performance of the sample students on the test in favor of males. This result is considered normal; because the sample of students originally possesses CT, and since there are no studies prove that the male students 'superiority over the female in thinking, whether it is logical or algorithmic thinking. Therefore, the students' male superiority in the sample may be due to their being more numerous and superior in programming than the female, and they possess the ability to solve and program problems by most programming languages are faster than female

students, based on the practice and experience of researchers with their students. Thus, Students in Computer Science/Faculty of the Education/University of Baghdad possess a reasonable level of computational thinking. It is statistically significant for the benefit of male students.

Table 1. The indication of the different performance the average performances

	No.		Mean	Std. Devi.	Std. Error Mean	T-test Calculated	T-test Tabular	Degree of Freedom	Statistical Significance
Test 1	100		15	2.465	0.246	12.195	1.664	99	0.05
Test 2	Male	60	15.26	3.907	0.504	4.370		98	
	Female	40	14. 6	3.820	0.604				

Test 1: the difference between the mean performance of students on CT test

Test 2: the "difference" between "average performance" of male; female students on the test.

5 Conclusion

CT is a method of solving problems. Universities and educational institutions should adopt it, and academics should be aware of how this affects them and their students. To invite academics and specialists in computer science education to research how to apply computational thinking skills in computer courses as well as in other subjects such as mathematics and sciences. Paying attention to teaching computational thinking skills among students of scientific colleges in a manner consistent with modern technological innovations.

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