



## COMPUTATIONAL THINKING FOR STUDENTS AND EDUCATORS

## Computer Science

Subhankar Mishra National Institute of Science Education and Research, Bhubaneswar, Odisha - 752050

## ABSTRACT

Computational Thinking (CT) will be an essential skill with implication in every field of human interest in the 21st century. It is an approach to problem solving derived from concepts of computing mainly abstraction and automation with applications across disciplines. With the exponential growth in science and technology, in this paper, even though computational thinking is not a new concept, the importance of computational thinking is revisited. A questionnaire survey was performed online for about 165 students at National Institute of Science and Technology (NISER) and questions about knowledge and need of CT were asked. The question seeks to assess the potential as well as the need of CT among the Indian academia as well as the current state of CT in Indian schooling system. In effort to address the concern raised by the students, it is imperative that the computational thinking should be given an important priority in the future both by students as well as educators as India starts competing for its place in the world.

## KEYWORDS

computational thinking, educators, computer science, algorithms, students

## INTRODUCTION

*Computational Thinking will be a fundamental skill used by everyone in the world by the middle of the 21st Century. It will as important and generic skill as reading, writing and arithmetic and it will spread as computing and computers spread across the world.* This was the vision as predicted by Wing [1]. In the words of Google [2] Computational thinking (CT) is a problem solving process that includes a number of characteristics, such as logically ordering and analyzing data and creating solutions using a series of ordered steps (or algorithms), and dispositions, such as the ability to confidently deal with complexity and open-ended problems.

Computational Thinking [3] mainly deals with problem solving across disciplines in a way that many other human or machine would understand and also answer the question if humans or machines would be better at solving this problem. Although there are many elements in the computational thinking, some of them as captured by Google are shown in Table 1:

**TABLE – 1**  
**ELEMENTS OF THE COMPUTATIONAL THINKING**

Element	Explanation
Decomposition	Breaking the problem, data or the process into smaller and manageable parts
Pattern Recognition	Observing patterns, trends, and regularities in data
Abstraction	Identifying the general principles that generate these patterns
Algorithm Design	Developing the step by step instructions for solving this and similar problems

There are many other additional instances across the streams and across continents that necessitate CT as a tool for our future generation. Although this is majorly propelled by the computing group, its applications as stated above applies to all disciplines as shown in Table 2. It helps the students connect the real world with what has been stated in their books and therefore inculcates the idea of immersive learning. Although the computational thinking has been around for a while, in India its acceptance has not been that evident or significant. Therefore, using the NTSC [4] as a platform, I would like to communicate this idea again with the other educators involved in Science education which would in-turn increase the level of scientific awareness in them as well as students directly or indirectly by them.

**TABLE – 2**  
**CT CONCEPTS AND THEIR APPLICATION IN OTHER DISCIPLINES**

Concept	Subject Area Application
Break a problem into parts or steps	Physics: Studying the problem in various dimensions, properties and slowly molding into smaller problems

Recognize and find patterns or trends	Economics: Find cycle patterns in the rise and drop of the country's economy.
Develop instructions to solve a problem or steps for a task	Culinary Arts: Write a recipe for others to use.
Generalize patterns and trends into rules, principles, or insights	Chemistry: Determine the rules for chemical bonding and interactions.

In this paper, the importance of computational thinking is mainly addressed. A questionnaire survey was performed online for about 165 students and questions about knowledge and need of CT were asked. The question seeks to assess the potential as well as the need of CT among the Indian academia as well as the current state of CT in Indian schooling system.

## METHODOLOGY

A short questionnaire of 7 questions was designed to measure the following variables:

- Current state of 2 student (2 questions)
- Past experience (1 question)
- Current understanding of CT (2 questions)
- Future Applicability of CT (1 question)
- Future Need of CT

Majority of the question targeted either a yes or no answer from the students. Except the question that asks for their CGPA which is then converted into the range for statistical analysis. Note that the batch 2018 students do not have any CGPA report yet.

The set of questions were asked to the students of NISER Integrated M.Sc. students who are currently on path to becoming science graduates. It was open to the batches of 2015, 2016, 2017 and 2018. The questionnaire was floated on Google Forms [5]. It was restricted only to the users of NISER, and personal information other than batches and cgpa was not collected. CGPA although a personal was converted to range, hence the anonymity and privacy is well maintained.

## RESULTS

Completed questionnaires were obtained from 165 students from 460 students, giving a response rate of 36%. The figures and their corresponding questions are noted as below:

- Composition of the responses as shown in Figure 1. Although we expected similar number of participants from all four batches, the new batch participated in overwhelming numbers occupying almost 55% of the total participants. Hence to give an unbiased approach of the analysis to follow, we have categorized responses of each question into batches to look at overall as well as granular response from each batch.
- Figure 2 shows the response to the students' knowledge of the term "CT".
- Figure 3 shows the response to the students' knowledge of some of the techniques of Computational Thinking without directly asking

them if those elements actually contribute to computational thinking.

- Figure 4 shows the response if the schooling computer science course ever had the elements of computational thinking.
- Figure 5 shows the response if the computational thinking techniques would have helped them through their tenure at NISER.
- Lastly, Figure 5 shows the response if they would recommend CT course during schooling.

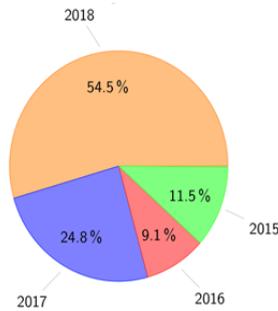


Figure 1: Composition of the responses - Students from the various batches

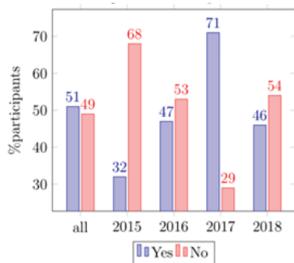


Figure 2: Understanding of term CT

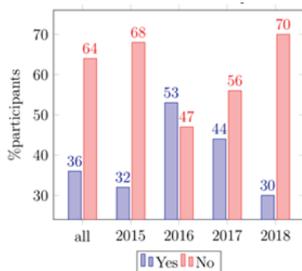


Figure 3: Previous course on elements of CT

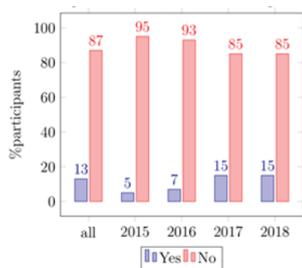


Figure 4: Did school Computer Science course cover CT

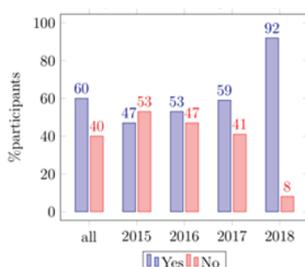


Figure 5: Would have CT techniques helped you?

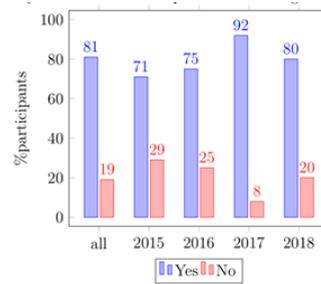


Figure 6: Would you recommend Computation Thinking during schooling?

**DISCUSSION**

Both Figure 2 and 3 shows the lack of the knowledge of the student about the computational thinking as a term or even the techniques involved in the computational thinking process, which is indeed a serious need of the hour.

Following that, in Figure 4 it is evident that even though students had a computer science course during their schooling, it failed to add some or all elements of computational thinking. Although we do understand now, that computational thinking does not equate with computer science, however their overlap begs to include some curriculum from computation thinking into the computer science course taught during school.

Figure 5 shows the growing need of computational thinking with the age. Here 2018 batch has overwhelmingly desired the need of such course for their academic career.

Figure 6 follows up the from the question asked in Figure 5, however here is there is a clear trend of recommending computational thinking to be included during schooling and it shows across all the batches.

**CONCLUSIONS**

I believe all educators and students alike should learn computational thinking; irrespective of their age, stream, branch, or subject of study. The importance of computational thinking has been reiterated by the scientists all over world as well as repeated by the world leading companies. Solving tomorrow's problems and finding solutions for them would need the creative thinking and problem-solving skills of our students. Educators with the computational thinking knowledge would be in a better place to incubate tomorrow's computational thinkers and technology entrepreneurs.

In Future, I would like to expand on the survey to include Engineering and Medical students from IIT Bhubaneswar and AIIMS Bhubaneswar as well as faculties of those institutes including NISER, which would help the understanding the requirement in all the science streams. Further plans also include tapping into Arts and Commerce colleges for the potential need of Computational Thinking in those streams as well.

**ACKNOWLEDGEMENT**

I would like to thank the students of NISER from the Integrated M.Sc. batches for participating in the survey about Computational Thinking.

**REFERENCES:**

- [1] Wing, Jeannette M. "Computational thinking." Communications of the ACM 49.3 (2006):33-35.
- [2] Exploring Computational Thinking". <https://edu.google.com/resources/programs/exploring-computational-thinking/>, Accessed on 20th October, 2018.
- [3] Google : "What is Computational Thinking?" [https:// computational thinkingcourse.withgoogle.com/unit](https://computationalthinkingcourse.withgoogle.com/unit), Accessed on 20th October, 2018.
- [4] 9th National Teachers Science Congress (NTSC). <http://www.ntscindia.in>. Accessed on 20th October 2018.
- [5] Google Forms <https://www.google.com/forms/about/>