

What is Computational Thinking and Why is it So Important?

A brief summary

As our global economy grows more focused on information and less focused on manufacturing, computational thinking is becoming an essential skill for students to possess. While computational thinking's foundation is computer science, it can be universally applied to any subject, including literature, economics, mathematics, chemistry and others. No matter what subject your student is most interested in, computational thinking can help him or her excel in studying that subject in school as well as excel when working in that field as an adult. Robotics is an ideal starting point for students to learn computational thinking. It can help lay the foundation for computational thinkers as young as 6 years old.

Computational thinking is a new development in problem solving that is changing the way students learn and how employees overcome challenges in the workplace. Jeannette Wing, a professor of computer science at Carnegie Mellon, introduced the term “computational thinking” in March 2006 in an article in a leading information technology journal.

In her article, Wing described computational thinking as “computational methods and models that give us the courage to solve problems and design systems that no one of us would be capable

of tackling alone.” She also said that computational thinking “involves solving problems, designing systems, and understanding human behavior, by drawing on the concepts fundamental to computer science.”

In short, computational thinking is a process that makes the toughest challenges more manageable. And, while computational thinking draws on concepts fundamental to computer science, it can be used to solve a wide range of problems in a number of different subject areas and industries.

That’s why computational thinking is such an important skill for today’s students to learn.

What Exactly is Computational Thinking?

Computational thinking’s definition is complex. To help her audience understand the concept, Wing broke down in her original article what computational thinking is and what it is not. She wrote that computational thinking is:

- **Not programming:**
Computational thinking requires thinking at “multiple levels of abstraction” rather than simply the ability to program.
- **Not memorization:**
She envisioned computational thinking as a skill that all humans will someday need to master if they want to function in modern society.

- **A way that humans, not computers, think:**
Computational thinking is a problem-solving method that captures a human’s imagination and creativity that computers cannot replicate.
- **Complementary to mathematical thinking:**
Computing devices are limited by their foundational sciences. Computer scientists are forced to think computationally when they want to expand their ideas beyond the physical world.
- **A method for developing ideas, not artifacts:**
Computational thinking holds the power to solve problems, better communicate with people and the world around us, as well as to better manage daily life.
- **For everyone, everywhere:**
Again, computational thinking isn’t just for computer science. It is a concept that can be applied to social science, arts, humanities and everyday life.

Today’s Students Need Computational Thinking for Tomorrow’s World

The world and the global economy are changing around us. For the bulk of the 20th century, we lived in a manufacturing economy — one in which the creation, distribution and sale of goods created jobs. But the 21st century and its advances in technology have created an information economy — one in which knowledge and skills are the currency rather than goods produced in a factory or on an assembly line.

Because of this shift from a manufacturing to an information economy, today’s students must learn differently and develop different skills than students of just a few years ago. In the 20th century, a student could study and work hard, attend a university, and then count on a steady, secure job related in some way to manufacturing. The goal of that job was almost always to make things and to make them as efficiently and inexpensively as possible. But, today, those manufacturing jobs are quickly disappearing. The economy is now driven by information and knowledge, and jobs in all industries require more advanced skills — skills that include the ability to think computationally:

- Doctors will save more lives by optimizing the exchange of organs between donors and recipients, as well as through advanced drug design that avoids the creation of drug-resistant disease strains.
- Artists will develop new modes of human experience by applying the tools needed to express themselves computationally.
- Internet users will apply computational thinking to develop new services and experiences.

How Does Computational Thinking Help Your Student?

Students who learn how to think computationally will be the ones who participate in these new developments — and they will be the ones who enjoy steady, secure and lucrative employment as

other struggle through the transition from manufacturing to information.

Computational thinking offers students three main benefits:

- **Problem-solving skills:**
Students who learn how to think computationally are the ones who will be able to overcome challenges and come up with solutions to complex problems.
- **Creative thinking abilities:**
Students who learn how to think computationally are the ones who will be able to research, gather and understand new information, and then to apply that new information to issues and projects or all kinds.
- **Autonomy and confidence:**
Students who learn how to think computationally are the ones who will feel comfortable working in groups as well as confident when forced to take on a challenge independently.

Computational thinking is also helpful in any number of subjects that your student is pursuing in school. It can help students explore new information and ideas, and it can be universally applied — no matter what they're interested in studying and no matter what line of work they want to someday enter.

Google's Computational Thinking for Educators¹ curriculum indicates how computational thinking is helpful to students outside of computer science, including in the subject areas of:

- **Literature:** Computational thinking can help students break down and analyze poems with regard to structure, tone, meter, imagery and more.
- **Economics:** Computational thinking can help students identify patterns and cycles that affect the rise and fall of a nation's economy.
- **Mathematics:** Computational thinking can help students develop a reflexive understanding of difficult concepts, such as the rules for factoring second-order polynomials.
- **Chemistry:** Computational thinking can help students visualize the rules that govern chemical bond and interactions.

Robotics Helps Students Develop Computational Thinking Skills

A strong connection exists between robotics and the development of computational thinking abilities. MIT Professor Seymour Papert first discovered this connection in the 1960s when he taught students to program a

¹ "What Is Computational Thinking?" Computational Thinking for Educators.

robotic turtle to make specific moves and take certain actions².

Papert called the robotic turtles “objects(s) to think with.” His students would watch the robotic turtle encounter an obstacle. The students would then imagine how they would navigate around the obstacle. And, finally, the students would apply that solution to the program, which connect robotics and computational thinking. For these early learners, the exercises can be simple — just describing the actions of a robot as it demonstrates its capabilities and range of motion can serve as a beginning in computational thinking. Once this simple introduction is made, students can take on more and more complex exercises to develop greater abilities

Help Your Student Learn to Think Computationally

Computational thinking can help your student build a bridge to the information economy. It can help all students take a first step toward becoming tomorrow’s outstanding professionals and industry leaders — in computer science, of course, as well as in a wide range of industries, everything from business to medicine to law and more.

Unfortunately, today’s school systems haven’t fully implemented the curriculum needed to prepare students for the information economy. While strides have been made to include subjects and lessons more relevant to what students will

experience in tomorrow’s workforce, it’s simply not enough.

Where will your son or daughter develop the computational thinking skills needed to excel in school and thrive in his or her career to come?

Given the strong connection between robotics and computational thinking, even with students as young as age 6, an introductory course into robotics is an ideal place to start. At AppleTree.ai, we offer that introductory course in the form of our Robotics Bootcamps.

These Bootcamps introduce students to the ideas and concepts of coding, programming, robotics and computational thinking. But the hands on nature of our Bootcamps makes the learning process fun — in fact, our participants aren’t even aware of the essential skills and abilities they develop while taking part. They only know that they’re solving problems and achieving success alongside their peers and friends.

Help your student take a first step toward thinking computationally when you learn more about courses at UCode.

² Kamada, Toshiyuki, Hiroyuki Aoki, Shuji Kurebayashi, and Yoshikazu Yamamoto. “Development of an Educational System to Control Robots for All Students.” Lecture Notes in Computer Science Informatics Education — Supporting Computational Thinking(n.d.): 63-74.