# DEVELOPING THE NEXT GENERATION OF COMPUTATIONAL THINKERS

An Intel® Solution Brief for Education

Computational thinking is the ability to take a complex problem, understand what the problem is, develop possible solutions, then present these solutions in a way that a computer, a human, or both, can understand. It is an approach to solving a problem that empowers the integration of digital technologies with human ideas. It does not replace an emphasis on creativity, reasoning and critical thinking. Instead, it reemphasizes those skills while highlighting certain ways to organize a problem so that a computer can help where appropriate.

We all need to understand how, when, and where computers and other digital tools can help us solve problems, and we all need to know how to communicate with others who can assist us with computer-supported solutions. Computational thinking can help students realize that computers are available to solve their problems and extend their thinking, and create solutions.

> Computational thinking helps the current generation of student understand how AI works as their working world will be dominated by technologies that harness AI.
>
> CSFORALL, COMPUTATIONAL THINKERS, 2017

One of the best ways to teach computational thinking is through computational modeling which involves constructing, refining, and evaluating systems using mathematical and graphical tools. By constructing these models and simulations, students discover the inner workings of a system using scientific and mathematical systems processes.

Computational modeling underpins many teaching and learning standards in all subjects and enhances a learner's ability to solve problems and engage in higher order thinking.

- Students use algorithms to solve problems and enhance that problem solving through the use of technology tools.
- Students analyze text and constructing complex communications.
- Students evaluate large data sets and identifying patterns as they conduct scientific investigations.

Educating students in computation thinking through modeling is not primarily meant to lead to jobs in the field of computer science, but those students who do follow that path will be much better positioned to be successful regardless of their course of study if they have computational thinking skills and dispositions ingrained as habits. With computer science enrollments declining, a pipeline into this high-paying, in-demand occupation will benefit the students, the institutions of higher education, and the country.

## USING MODELING AND SIMULATION TOOLS POWERED BY INTEL®

### Benefits for administrators

- Powerful Intel® Core™-based devices help to future-proof your investment for years to come.
- Supports teaching and learning of real-world skills and practices used throughout a school system.
- A computational thinking mindset helps to focus attention on data-driven decision-making.

### Benefits for educators

- Can improve student computational thinking skills no matter what discipline they teach.
- Can have visual and tangible evidence of student understanding of a system.
- Can individualize instruction based on the model selected by a student or team.

### Benefits for students

- Learn using professional tools and transfer skills to work or higher education.
- Practice problem solving on a model that they have created.
- Develop understanding of mathematical basis for both scientific and everyday models.

# INNOVATION HUBS FOSTER HIGH-IMPACT LEARNING

Site-based innovation hubs can be used across disciplines in order to provide students the best opportunities to do computational modeling. These hubs must have tools for data abstraction, analysis and visualization so that students can understand a system. Once a system is accurately modeled, students will have tools to simulate changes to the system and to measures the effects in five phases.

### Collection
Modeling begins with a description of the factors in the system using primary data obtained through sensors, scanners and other input devices or through secondary data obtained from databases, articles, formulas or the adaptation of existing models.

### Analysis
Students analyze the systems they are studying to determine critical factors. They will use tools for content analysis, flow charting, and diagramming.

### Modeling
While the system is being described through data, students need the tools to create a mathematical model of the system. As more data is added, the model changes and students see what added factors are needed for the model to represent the system accurately.

### Simulation
At any time, the students can evaluate the model by simulating a change in one of the factors. If the result of the change matches the known behavior of the system then the students know that the model is accurate. If not, students will re-analyze the system to determine whether there are unaccounted factors or unexpected relationships between factors.

# LEARNING SOLUTION RECOMMENDATIONS

### Computers
Most computational modeling software requirements call for computers with multiple cores (e.g., Intel® Core™ i5 or better), high speed and hyper-threading along with more than 16gb RAM to assure smooth modeling and simulation.

### Displays
Multiple displays will allow the model to be shown while changes to data and formulas are entered.

### Computational modeling software
**High School**
Maple*, Mathematica*, MATLAB*

**K–8**
StarLogo Nova*, NetLogo*

### Data collection tools
**Science peripherals**
Accelerometers, weather stations, light sensors, etc.

**Social Science**
Survey and polling software, content analysis software

### Data analysis tools
**Statistical**
Tableau*, SPSS*, Gapminder*

**Access to data sets**
Data.gov, census at school

"The intellectual core of computational thinking is about formulating ideas with enough clarity...that one can tell a computer how to do them."

STEPHAN WOLFRAM. 2016

**To learn more about how Intel powers the latest generation of devices for education contact your Intel Account Executive or visit [www.intel.com/education](www.intel.com/education).**