

# WHAT IS COMPUTATIONAL THINKING AND WHY DOES IT MATTER?

**Computational thinking skills are important for all students, not just for future computer scientists. That's one of the key messages from a new report commissioned by the Department's Education for a Changing World initiative, and a message bolstered by growing international evidence.**

The report, [Coding and Computational Thinking: What is the Evidence?](#), by James Curran, Karsten Schultz and Amanda Hogan from the University of Sydney, explores the evidence base around the teaching of computational thinking, its relationship with coding and implications for school and schooling systems.

This research on computational thinking sits within a broader stream of Education for a Changing World work examining the range of [thinking skills](#) students will need to succeed in a rapidly changing world. These capabilities include critical and creative thinking, problem solving, ethical reasoning and metacognition.

In 2017, we asked internationally-renowned professor of computer science, Jeanette Wing, [her thoughts](#) on what computational thinking is and why it matters. Wing, who some 20 years ago first broadened computing science to the wider notion of computational thinking, defines this as the “thought process involved in formulating a problem and expressing its solution in such a way that computer – human or machine – can effectively carry it out”.

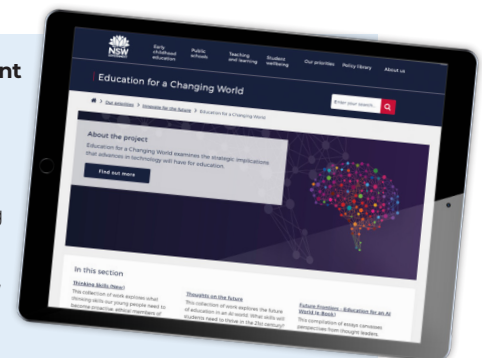
Wing sees computational thinking as a more fundamental and essential capability than just telling a computer what to do, especially given

the central role of technology in nearly every aspect of 21st century life. Computational thinking enables effective engagement with technology, its associated data and algorithmic elements. It is far broader than the subsidiary notion of coding. As Wing puts it, “computational thinking is first and foremost what humans do. When you are programming you are using computational thinking, but the opposite is not true: you can be doing computational thinking and not be programming at all.”

Toby Walsh, a globally recognised expert in AI at UNSW and author of [another of our occasional papers](#), agrees that computational thinking is vital in a world increasingly transformed by AI. While not all people will need to know how to code, all young people must have an understanding of the building blocks of computation. If people believe technology to be mysterious and “magical”, they risk being manipulated by technology rather than reaping its

## The NSW Department of Education's Education for a Changing World

initiative is exploring the different 'thinking skills', such as critical and creative thinking, problem solving and computational thinking, which students will need to thrive in a rapidly changing world. Stay connected with our work via our [website](#). Follow us on [twitter](#), join our [mailing list](#) or send us an [email](#).



potential benefits. And with the expanding scale of intelligent machines powered by AI, the need for widespread computational thinking capabilities has never been greater.

While computational thinking clearly has close ties to coding, it extends well beyond it to encompass significant cognitive processes – including problem decomposition, abstraction, pattern recognition and algorithms – that will enable students to access learning whether specifically in computer science or not.

This broader view is why the authors of the new Coding and Computational Thinking (CACT) report question a narrow focus on coding in schools, saying that teaching children to code without complementary computational skills is like: “Pushing the buttons of a machine in a repetitive fashion without providing any direction as to the function of the machine or to the design of its output”.

The general consensus amongst researchers, including the authors of the CACT report, is that computational thinking is applicable across all kinds of disciplines, from science to creative arts and the humanities. For example, the ability to break down a problem and develop a solution is one that all students will find useful across their studies and their future working lives.

The CACT report highlights the expanding number of countries that are integrating computational thinking into school education. While a key driver for these countries is to foster logical thinking and problem-solving skills, some also seek to develop specific ICT and coding skills to attract students into computer science, to drive growth in the ICT sector and support technology skills needs across the workforce.

The CACT reports also notes that there are many different approaches to teaching computational thinking. For example, Finland focuses less on programming and more on computational thinking and takes both a cross curricular and a subject matter approach. Computational thinking is included in ICT, one of seven “transversal competencies” taught across the curriculum. It is also specifically taught within mathematics and crafts.

Closer to home, the concept of computational

thinking is an important part of the Australian Digital Technologies curriculum, recently adopted by NSW. NESA has also [published a guide to teaching computational thinking](#) across existing syllabuses. The guide supports the idea that computational thinking is applicable across disciplines and in some cases can be taught independently of technology. For example, students can be taught about problem solving and abstraction while exploring a particular text in English.

As highlighted by the CACT report, one of the difficulties with teaching computational thinking and developing support materials for teachers is that we are still trying to work out the best time and method to teach particular concepts across K-12. Understanding of how computational thinking concepts are learned is still in its infancy, compared to other well-established disciplines such as mathematics. While assessment tools and resources are available, many are in pilot form and are yet to be rigorously evaluated.

Resources to support effective teaching of computational thinking will be crucial. Lessons from international experience may be useful, such as from the UK’s Computing at School initiative that provides widely available and accredited professional development. This also raises the question of whether initial teacher training would benefit from a greater focus on computational thinking and coding.

What is clear from the CACT report is that whilst the evidence base for what works best is still being developed, Australian and international educators have moved significantly toward incorporating computational thinking and not just coding into curriculum and teaching.

The emerging global consensus also underscores the growing urgency to embed strong computational thinking capabilities as an essential component of school education from the early years through senior secondary. These capabilities support far more than just computer programming or computer science; they enable students to access learning across the curriculum, to enjoy stronger employability, and to gain greater mastery of their increasingly complex, technological worlds.