The developing concept of "computational thinking"

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To help develop a theoretical model for this study and promote a greater understanding and appreciation of the nature of computation and the value of the ongoing quest for a definition a brief outline of the changing views and ideas of computational thinking are shown below (Table 1).

Decade	Significant ideas on computation and computational thinking	Rationale Influences and Discipline
1930's	Gödel, K. (1934) suggested Computational Thinking was the evaluation of **recursive functions.** Turing, A. (1937) Described a **sequence of states** of an **abstract** machine with a control unit and a tape. He suggested they were functions that could be **evaluated** by **algorithms** in their system.	Computation was the **mechanical steps** followed to evaluate '**mathematical**' functions. Computers were people doing '**mathematical**' computations – people employed to run calculators doing calculations to support war efforts. First digital computers were emerging.
1960's	Computer Science curriculum at University and Computation defined as **information processes generated by algorithms** – Three strands: • Information structures and processes • Information processing • Methodologies 'The paradigm of computing was based on the algorithm (the 'recipe' whereby the machine could be made to do something useful.) (Beardon, 2006:1) Pfeiffer (1962) Considered computers as thinking aids and forcing users to think through their problems along different lines. Began idea that computers will accelerate the rate at which we ourselves learn, just by being around. Perlis (1962) advocated all college students, regardless of subject should learn **programming**. Spoke of a **theory of computation.**	Shift in understanding computation – **now connected to activities in and around the computer,** rather than as the algorithmic nature of the information process. Emphasis was on writing efficient and accurate procedures for machines. Phrase '**algorithmic thinking**' used to **describe how computer scientists' thought processes were different to other scientists**. Although considered as thinking skills specific to computer science, notion of them being **beneficial to other disciplines** was emerging.

1970's	Algorithms distinguished from computation Dijkstra (1968) – suggested that: **Algorithm** was a static description **Computation** was a dynamic state **sequence** evoked from a machine by an algorithm – it was the actual work.	**Interest in computation outside** of mathematics and computer science. Emphasis **on data processing**- due to need for processing vast quantities of repetitive data. E.g. payrolls production. Structured Programming movement launched.
1980's Early	Arden (1983) – tied definition of computation to a concern for **automation** (**algorithmic thinking**) Papert (1980's) Introduced computers and programming to schools as a vehicle for problem solving skills and discovery.	Computation now **connected to actions of machines** **Programming and computers introduced to schools**
Mid – late	**Computational thinking** – new way of doing Science Linked to way of thinking and problem solving – Practice of discovery and **way of thinking.**	Supercomputers main tools of Computer scientists. Some acceptance that computation was **more than machine activity.**
1990's	Computation seen as natural process – challenging definitions which tied it to Computer Science. 'Theories of everything' Mitchell (1995)	Study of information processes – natural and artificial. Idea that all systems processing information must be governed by specific rules.
2000-	Debate on CT - idea of CT: **New problem solving strategies** and **ability to test notions in real** and virtual world and allows people and computers to work together to solve problem. Not about thinking like a computer. (Wing 2006) Bundy (2007) **Computational thinking is pervasive** Denning (2009) **Computational thinking – one of the Great Principles** of Computer Science – over-stating Computational thinking would damage discipline of Computer Science. 2009 – ICT reviewed and considered weak in schools and university level 2011 – Computational Thinking is essential as **foundation to programming**.	Notion that computer allows users to think in different ways. Debate begun: CT is **essential for learning** and a **set of problem solving/thinking skills** that were **transferable** to other disciplines. '**v**' Computer Science Specific - **One principle of computer science.** Computer Science regarded as subject to be introduced at school level – **Computational thinking core** of the subject at levels 1 – 3 (UK)

Table 1: Changing ideas of computation and computational thinking.