UNIVERSITY OF CAMBRIDGE
Raspberry Pi Foundation
RASPBERRY PI COMPUTING EDUCATION RESEARCH CENTRE

What does research tell us about the big picture in computing science education?

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A question about Computing Science …

With which of these statements do you most identify? Or can you rank them?

A The primary goal of computing science education should be to enable students to use computational tools for scientific inquiry.

B Computing science education should focus on creativity, collaboration, and real-world problem-solving.

C Computing science should be taught as a discipline that emphasizes problem-solving using algorithmic techniques.

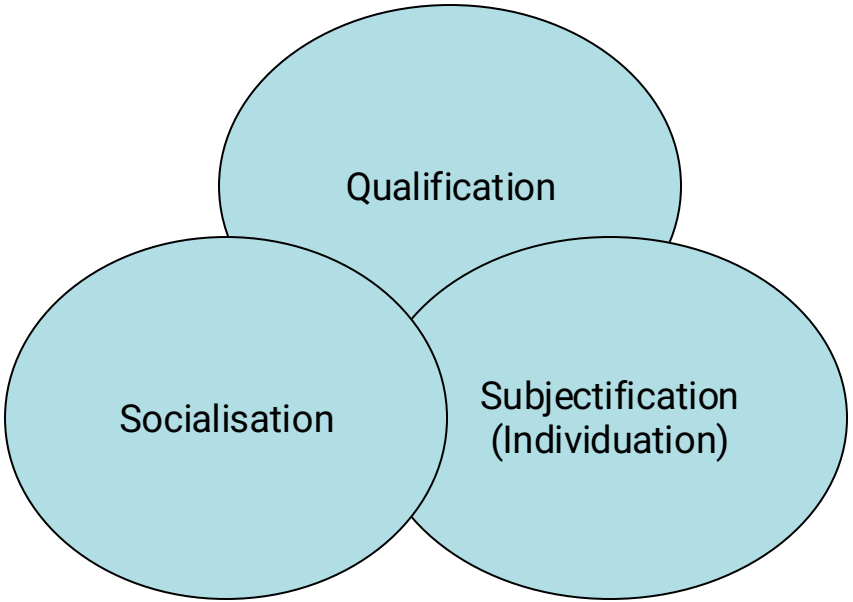
D Computing science education should emphasize the social and ethical implications of technology.

What is education for? (Biesta, 2009)

Qualification (knowledge, skills, understanding, ability to ‘do’)

Socialisation (insertion into ‘orders’ and norms of society)

Subjectification (development of autonomy, orientation towards human freedom)



Three ‘purposes’ of education, but all are important

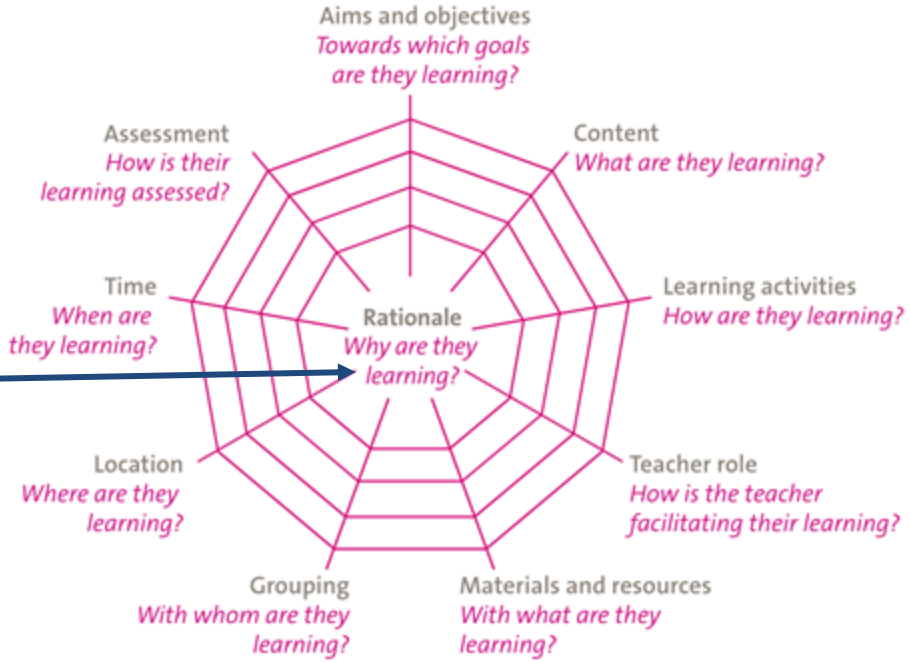
What is education for? (Biesta, 2009)

Mathematics Education		
Qualification	**Socialisation**	**Subjectification**
“providing students with mathematical knowledge and skills and, most importantly, mathematical understanding in order to become proficient in mathematics” (p. 43)	“Socialisation into a world in which mathematics carries importance. Socialisation into such a world can also be an explicit aim of mathematics education” (p.43)	“ a person who, through the power or mathematical reasoning is able to gain a more autonomous or considered position towards tradition and common sense.” (p.43) e.g. Division raises issues relation to sharing and questions about fairness and justice…

How can this apply to computing science?

Designing a curriculum

Why are they learning?



(Van Den Akker, 2013)

Conceptualising four theoretical traditions of computing education

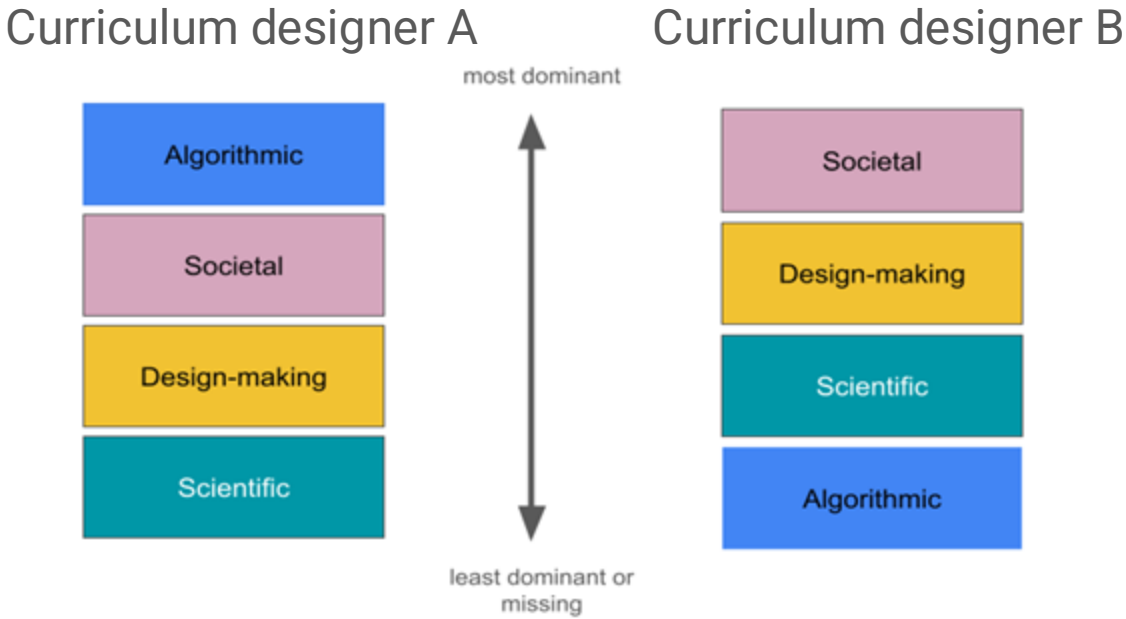
- Algorithmic tradition
- Scientific (epistemic) tradition
- Design and making tradition
- Societal tradition

	…is anchored in a view of computing as a discipline that is…	…is important because…	…enables computing educators to…
Algorithmic tradition…	…about algorithms, computation, and processes that transform information.	…it enables education to focus on the field's unique ways of thinking and practising.	…focus on developing learners' ability to "think computationally" and the "traditional" skills, competencies, and knowledge central to the discipline.
Science tradition…	…about a specific view on the world and understanding the world	… it focusses on using computational concepts and approaches to make inquiries about the world (both the natural and the artificial world)	… focus on modelling, simulation and using computing as a tool for inquiry
Design and making tradition…	…about designing and building artefacts within material and human resources.	…it highlights the practices and participation relevant to the art and skill of building digital tools and solutions.	…anchor projects in learners' ideas, interests to cultivate creativity, collaboration and (real-world) problem-solving.
Societal tradition…	…about artificial, human-made ideas and technologies should be aware of its responsibility to contribute to the well-being of individuals, societies and humanity.	…it demonstrates that computing cannot be understood without reflecting on its embeddedness with their surrounding societies and their societal values and norms.	… it enables education to show the relevance of computer science and its importance and for students to be responsible practitioners of computing

Table 12: Four traditions in computing education

Schulte et al (2024) What do we talk about when we talk about computing education. ITICSE Working Group Report

Which tradition is most pertinent for you?



Some beliefs associated with each tradition

Algorithmic

- Computing education should focus primarily on developing students' ability to think algorithmically.
- Understanding algorithms and computational processes is more important than understanding the data those algorithms manipulate.
- Learning to program is essential because it teaches the fundamental principles of computation
- Computing should be taught as a discipline that emphasizes problem-solving using algorithmic techniques.
- The most important aspect of computing education is teaching students how to write efficient and effective algorithms.

Scientific

- Using computational models and simulations is essential for understanding complex systems and phenomena.
- The primary goal of computing education should be to enable students to use computational tools for scientific Inquiry.
- Computing education should integrate scientific methods such as hypothesis testing, data collection, and analysis.
- Computing should be seen as a means to understand and explore the world, both natural and artificial.
- Learning computing is valuable because it teaches how to think critically and analytically like a scientist.

Societal

- It is important for students to understand that computing is not a neutral discipline but is value-laden.
- Computing education should emphasize the social and ethical implications of technology.
- Computing education should foster a sense of responsibility towards individuals, societies, and humanity.
- Students must learn how computing systems are shaped by societal values and power dynamics.
- A critical aspect of learning computing is understanding its impact on equity, justice, and social good.

Design/making

- The process of making and sharing digital artefacts is more valuable than the final product itself.
- Students learn best when they are actively engaged in designing and creating digital or physical artefacts.
- Learners should be empowered to se themselves as designers and innovators in computing.
- Building personally meaningful projects is the best way to learn computational concepts.
- Computing education should focus on creativity, collaboration, and real-world problem-solving.

Schulte et al (2024) What we talk about when we talk about K-12 computing education. ITICSE Working Group Report

The computing curriculum in England draws on an algorithmic perspective

Aims of the national curriculum for computing

- Students can understand and apply the fundamental principles and concepts of computer science, including abstraction, logic, algorithms and data representation
- Students can analyse problems in computational terms, and have repeated practical experience of writing computer programs in order to solve such problems
- Students can evaluate and apply information technology, including new or unfamiliar technologies, analytically to solve problems
- Students are responsible, competent, confident and creative users of information and communication technology

Ofsted "research review" (2022)

Based on the above, high-quality computing education may have the following features

- The planned curriculum includes a breadth of knowledge relating to computer science, information technology and digital literacy.
- Declarative knowledge ('knowing that') and procedural knowledge ('knowing how') are identified, sequenced and connected in the curriculum.
- Skilful use of technology is underpinned by procedural and declarative knowledge.

	EU Informatics reference framework	K–12 US framework (concepts)	NCCE Taxonomy (for England)
Date released	**2022**	**2016**	**2020**
Algorithms	✓	✓	✓
Data and information	✓	✓	✓
Programming	✓	✓	✓
Creating media	✓ (digital creativity)	X	✓
Effective use of tools	X	X	✓
Design and development	✓	X	✓
Computer systems	✓	✓	✓
Artificial intelligence	X	X	✓ (2022)
Impact of technology	X	✓	✓
Networks	✓	✓	✓
Safety and Security	✓	X	✓
Human-computer interaction	✓	X	X
Modelling and simulation	✓	X	X
Responsibility and empowerment	✓	X	X

Table from Sentance (2024)

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26th November 2024

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