



RESOURCES FOR SCHOOL TEACHERS

How Did Modern Computing Emerge?

An intriguing thought-experiment arises from the *Atlas of Human Imagination*:

Who and what were the key developments that gave rise to modern computing?

Today, tens of thousands of scientists, engineers, and developers around the world are involved in the research, design and manufacturing of computer systems. Yet it's worth asking: can we trace this vast field back to its origins and identify the pivotal figures — the *top forty or so* men and women who truly pioneered it?

In this short study, we'll attempt to do just that: to identify the essential ingredients and chart the **intellectual evolution of computing**.

To begin, we need to deconstruct what a modern computer or smartphone actually is — a blend of the tangible and the intangible. There is mathematics and logic at its core; vast streams of binary digits (trillions of ones and zeros); programming languages, software, and apps; AI models and data networks; and, of course, the underlying electronics — chips, transistors, touchscreens, sensors and circuitry.

If we rationalise these components into categories, while keeping a historical perspective, they might look something like this:

1. Pure mathematics and logic
2. Mechanical systems and calculators
3. Biological brain systems and networks
4. Semiconducting materials and electronics
5. Human language, meaning, and linguistics
6. Programming languages, compilers, and software
7. Computer architecture, hardware and control systems
8. The World Wide Web and the internet
9. Neural networks and artificial intelligence
10. Cognitive science and psychology of computing

With these ten ingredients in mind, we can better understand how computing came to be at all. At first glance, the field appears strikingly **cross-disciplinary** — it touches mathematics, biology, physics, chemistry, linguistics, psychology, economics, and systems engineering. In essence, it spans almost the entire school curriculum.

By exploring the *Atlas of Human Imagination* and delving deeper, we discover that the roots of computation reach back nearly two millennia. The foundations of **mathematics** arose in India, Arabia, and Persia — forming the bedrock on which European **logic** and computational mathematics were later built. **Mechanical calculators** followed: intricate machines of metal and wood that could process numbers faster than any human. These devices inspired imaginative thinkers who began to visualise **algorithms** — abstract procedures that hinted at the potential for artificial calculation.

As **quantum physics** emerged in the early 20th century, it opened the door to semiconductors and microchips, triggering an electronics revolution. By the time of the Second World War, the first large-scale computers were under construction. The invention of the **transistor** then miniaturised these machines, allowing computers to migrate into offices and homes — which, in turn, created a need for user-friendly software, interfaces and a growing ecosystem of peripherals (screens, mouse, headsets, speakers).

By the 1980s, the **internet** began linking computers into a global network. From this connectivity grew email, web browsers and social media — the infrastructure of our modern digital age. Today, we are witnessing the rise of **artificial intelligence** as a new paradigm of computation — one offering enormous benefits, but also serious challenges.

Understanding how each breakthrough sparked the next is crucial. Every stage of progress relied on ideas that evolved, merged and cross-pollinated — culminating in the smartphone in your hand or the laptop on your desk.

On the following pages, the author has attempted to identify the **key steps and thinkers** in this extraordinary journey — from 600 AD to 2025. From this first analysis, it appears that roughly **forty visionaries** stand out as the primary architects of the digital age, the people who, step by step, **brought the joy of computing to humanity**.

The Intellectual Lineage of Computing — Almost 2000 Year Timeline

Era	Big Thinker(s)	Concept / Contribution	Connection to Computing	Category (see list above)
~600 AD	Brahmagupta	Defined zero, negatives, and number line	Foundation of all arithmetic and binary logic	1
~820	Al-Khwarizmi	Formalised algebra; introduced algorithms	Gave computing its very name “algorithm”	1
1200s	Al-Jazari	Created programmable automata and control mechanisms	Early concept of mechanical programming and robotics	2
1200s	Fibonacci	Replaced Roman numerals with ‘proper number’	Introduction of Hindu-Arabic numerals to Europe	1
1620	Bacon	Developed empirical science and rigorous testing	The “Scientific Method” underpins all future activity in computing	1
1642-1645	Pascal	Built first mechanical calculator “Pascaline”	Early hardware automation for fast arithmetic calculations	2
1679–1703	Leibniz	Invented binary system, symbolic logic, and a mechanical calculator	Binary maths (0 and 1) is the foundation of digital computation; early formal logic	1
1736	Euler	Founded graph theory	Basis for networks, data structures and algorithms	1
1763	Bayes	Introduced Bayesian inference	Foundation of machine learning and probabilistic reasoning	1
1801–1830s	Gauss	Developed modular arithmetic, number theory	Essential for cryptography, coding, and digital logic	1
1830s–1840s	Lovelace & Babbage	Designed mechanical computers and programmes	First concepts of hardware and software, including for music	2
1844-1906	Boltzmann	Statistical entropy	Precursor to information entropy; connects physics and computation	1
1847	Boole	Created Boolean algebra and true/false logic	Foundation of digital circuits, logic gates, and programming	1
1879–1890s	Frege	Founded predicate logic, syntax vs. semantics distinction	Foundation of formal languages, programming semantics, and AI reasoning	1
1900–1930s	Planck & Dirac	Founded quantum theory	Underpins semiconductors and quantum computing	4

1905	Ramón y Cajal	Neural networks	Foundation of the brain's structure	3
1931	Gödel	Incompleteness theorems, limits of formal systems	Defined limits of computation and provability	1
1936	Turing	Defined universal computation, Turing machine, early AI	Theoretical basis of all modern computers	1
1943–1950s	Wiener	Created cybernetics — control and feedback theory	Foundation of robotics, AI, and systems control	7
1945	von Neumann	Invented stored-programme architecture, game theory	Blueprint for modern computer design (CPU–memory model)	7,10
1947	Bardeen, Schockley, Brattain	Invented transistor switch	Physical basis of all digital electronics	4
1948	Shannon	Founded information theory, entropy, bit	The maths of data, compression, and communication	1
1952–1959	Hopper	Created compilers and high-level programming languages	Made coding accessible and scalable (via COBOL)	5,6
1950s	Chomsky	Linguistics, formal languages	Direct influence on compiler design, programming languages	5
1956–1970s	McCarthy	Coined “Artificial Intelligence”	Birth of AI and functional programming LISP	6
1960s–1980s	Knuth	Formalised algorithm analysis, <i>The Art of Computer Programming</i>	Defined computational rigour; invented TeX	6
1970-1980s	Kay	Design of software interfaces	Object-oriented programming, GUI and the modern PC paradigm	6
1970s–1990s	Gates	Founded Microsoft, popularised software and personal computing	Industrialised and democratised computing access	6
1970s-1980s	Simon & Minsky	Psychology, Artificial Intelligence and robotics	Pioneered cognitive simulation — modelling human problem-solving as a computational process	10
1980s–1990s	Feynman	Proposed quantum computing and computational physics	Inspired all quantum information science	4
1980s	Théry	Minitel early internet system	Developed precursor to internet, but only adopted in France	8
1989–1991	Berners-Lee	Invented World Wide Web and html coding	Created the global information network - the internet	8
1998	Page & Brin	Created PageRank algorithm	Defined information retrieval and search efficiency, via Google	8
1990s	Torvalds	Created Linux and Git	Embodied the collaborative, open-source, decentralised model of modern computing	6
2006–present	Hinton et al.	Developed deep learning, neural networks	Foundation of modern AI and machine perception	9

Conclusion:

From Brahmagupta's zero in ancient India to the algorithms of Al-Khwarizmi, from mechanical calculators to Bardeen's transistors, and from the logic of Turing to the neural networks of today, computing is the story of **ideas building on ideas**. Each breakthrough sparked the next, often in unexpected ways, crossing boundaries between mathematics, physics, biology, language, psychology and design. The forty visionaries highlighted here didn't just invent machines or write code — they **shaped the way we think, communicate and interact with the world**. Their combined genius reminds us that modern computing isn't just "tech"; it's a tapestry of human creativity, imagination and collaboration.

"Science is a Team Sport"

Mathematicians made computers think logically.

Physicists turned them into real objects.

Biologists made them learn like our brains learn.

Linguists made them understand language.

Programmers wrote the codes and apps.

Designers made them ergonomic and 'human'

FOR TEACHERS

Using the *Atlas of Human Imagination* in Lessons: Some Classroom Ideas

1. Build a Timeline of Computing

- Activity: Students create a visual timeline from Brahmagupta to Hinton et al., plotting key thinkers and inventions.
- Goal: Understand chronology and see how ideas build on each other.
- Variation: Make it interactive — e.g., each student presents one figure with a short “fun fact” or mini-sketch.

2. Role-Play Historical Figures

- Activity: Students research one figure (e.g., Ada Lovelace, Turing, Ramón y Cajal) and present a 2-minute “interview” as that person.
- Goal: Explore motivations, challenges, and the human story behind computing breakthroughs.
- Discussion Angle: How would these pioneers react to modern AI, smartphones, or the internet?

3. Compare Biological vs. Artificial Networks

- Activity: Use neural network models or diagrams to compare Ramón y Cajal’s neurons with Hinton’s deep learning networks.
- Hands-on Option: Use simple AI tools (like Teachable Machine by Google) to experiment with training a model.
- Goal: Connect biology and computing visually and conceptually.

4. Maths and Logic Puzzles

- Activity: Solve problems using binary numbers, Boolean logic or simple algorithms (like those of Al-Khwarizmi or Fibonacci sequences).

- Goal: See firsthand how early mathematical ideas underpin modern computing.
- Variation: Students design a “human computer” game where classmates follow an algorithm to solve a task, introducing *if* statements and *do* loops for example.

5. Debate: Ethics and Impact of Computing

- Activity: Host a classroom debate on questions such as:
 - “Should AI make important decisions for humans?”
 - “Is the internet more helpful or harmful?”
- Goal: Connect historical inventions to modern social and ethical issues.

6. Design a “Next Visionary” Project

- Activity: Students imagine the next big leap in computing - a device, software, app or idea.
- Format: Poster, prototype or short presentation.
- Goal: Encourage creativity while linking past breakthroughs to future possibilities. What’s coming next?

7. Cross-Disciplinary Connections

- Activity: Split students into groups by category (maths, biology, physics, linguistics, psychology, AI) and have them trace how their area influenced modern computing.
- Goal: Show computing is truly interdisciplinary and reinforce systems thinking.

8. Coding

- Activity: With some teacher help, try to create a Scratch or Python code that:
 - visualises the Fibonacci series as dots or a spiral
 - converts a decimal number into binary
 - asks a 10-questions guessing game
(a nod to Fibonacci, Leibniz and Turing, respectively)
- Goal: Show programming and computing in action.