# Computing Progression Pathways

| Pupil Progression | Algorithms | Programming & Development | Data & Data Representation | Hardware & Processing | Communication & Networks | Information Technology |
|---|---|---|---|---|---|---|
| **(pink)** | • Understands what an algorithm is and is able to express simple linear (non-branching) algorithms symbolically. **(AL)**<br>• Understands that computers need precise instructions. **(AL)**<br>• Demonstrates care and precision to avoid errors. **(AL)** | • Knows that users can develop their own programs, and can demonstrate this by creating a simple program in an environment that does not rely on text e.g. programmable robots etc. **(AL)**<br>• Executes, checks and changes programs. **(AL)**<br>• Understands that programs execute by following precise instructions. **(AL)** | • Recognises that digital content can be represented in many forms. **(AB) (GE)**<br>• Distinguishes between some of these forms and can explain the different ways that they communicate information. **(AB)** | • Understands that computers have no intelligence and that computers can do nothing unless a program is executed. **(AL)**<br>• Recognises that all software executed on digital devices is programmed. **(AL) (AB) (GE)** | • Obtains content from the world wide web using a web browser. **(AL)**<br>• Understands the importance of communicating safely and respectfully online, and the need for keeping personal information private. **(AL)**<br>• Knows what to do when concerned about content or being contacted. **(AL)** | • Uses software under the control of the teacher to create, store and edit digital content using appropriate file and folder names. **(AB) (GE) (DE)**<br>• Understands that people interact with computers.<br>• Shares their use of technology in school.<br>• Knows common uses of information technology beyond the classroom. **(GE)**<br>• Talks about their work and makes changes to improve it. |
| **(yellow)** | • Understands that algorithms are implemented on digital devices as programs.**(AL)**<br>• Designs simple algorithms using loops, and selection i.e. if statements. **(AL)**<br>• Uses logical reasoning to predict outcomes. **(AL)**<br>• Detects and corrects errors i.e. debugging, in algorithms. **(AL)** | • Uses arithmetic operators, if statements, and loops, within programs. **(AL)**<br>• Uses logical reasoning to predict the behaviour of programs. **(AL)**<br>• Detects and corrects simple semantic errors i.e. debugging, in programs. **(AL)** | • Recognises different types of data: text, number. **(AB) (GE)**<br>• Appreciates that programs can work with different types of data. **(GE)**<br>• Recognises that data can be structured in tables to make it useful. **(AB) (DE)** | • Recognises that a range of digital devices can be considered a computer. **(AB) (GE)**<br>• Recognises and can use a range of input and output devices.<br>• Understands how programs specify the function of a general purpose computer. **(AB)** | • Navigates the web and can carry out simple web searches to collect digital content. **(AL) (EV)**<br>• Demonstrates use of computers safely and responsibly, knowing a range of ways to report unacceptable content and contact when online. | • Uses technology with increasing independence to purposefully organise digital content. **(AB)**<br>• Shows an awareness for the quality of digital content collected. **(EV)**<br>• Uses a variety of software to manipulate and present digital content: data and information. **(AL)**<br>• Shares their experiences of technology in school and beyond the classroom. **(GE) (EV)**<br>• Talks about their work and makes improvements to solutions based on feedback received. **(EV)** |
| **(orange)** | • Designs solutions (algorithms) that use repetition and two-way selection i.e. if, then and else. **(AL)**<br>• Uses diagrams to express solutions.<br>• Uses logical reasoning to predict outputs, showing an awareness of inputs. **(AL)** | • Creates programs that implement algorithms to achieve given goals. **(AL)**<br>• Declares and assigns variables. **(AB)**<br>• Uses post-tested loop e.g. 'until', and a sequence of selection statements in programs, including an if, then and else statement. **(AL)** | • Understands the difference between data and information. **(AB)**<br>• Knows why sorting data in a flat file can improve searching for information. **(EV)**<br>• Uses filters or can perform single criteria searches for information.**(AL)** | • Knows that computers collect data from various input devices, including sensors and application software. **(AB)**<br>• Understands the difference between hardware and application software, and their roles within a computer system. **(AB)** | • Understands the difference between the internet and internet service e.g. world wide web. **(AB)**<br>• Shows an awareness of, and can use a range of internet services e.g. VOIP.<br>• Recognises what is acceptable and unacceptable behaviour when using technologies and online services. | • Collects, organises and presents data and information in digital content. **(AB)**<br>• Creates digital content to achieve a given goal through combining software packages and internet services to communicate with a wider audience e.g. blogging. **(AL)**<br>• Makes appropriate improvements to solutions based on feedback received, and can comment on the success of the solution. **(EV)** |
| **(blue)** | • Shows an awareness of tasks best completed by humans or computers. **(EV)**<br>• Designs solutions by decomposing a problem and creates a sub-solution for each of these parts. **(DE) (AL) (AB)**<br>• Recognises that different solutions exist for the same problem. **(AL) (AB)** | • Understands the difference between, and appropriately uses if and if, then and else statements. **(AL)**<br>• Uses a variable and relational operators within a loop to govern termination. **(AL) (GE)**<br>• Designs, writes and debugs modular programs using procedures. **(AL) (DE) (GE)**<br>• Knows that a procedure can be used to hide the detail with sub-solution. **(AL) (DE) (AB) (GE)** | • Performs more complex searches for information e.g. using Boolean and relational operators. **(AL) (GE) (EV)**<br>• Analyses and evaluates data and information, and recognises that poor quality data leads to unreliable results, and inaccurate conclusions. **(AL) (EV)** | • Understands why and when computers are used. **(EV)**<br>• Understands the main functions of the operating system. **(DE) (AB)**<br>• Knows the difference between physical, wireless and mobile networks. **(AB)** | • Understands how to effectively use search engines, and knows how search results are selected, including that search engines use 'web crawler programs'. **(AB) (GE) (EV)**<br>• Selects, combines and uses internet services. **(EV)**<br>• Demonstrates responsible use of technologies and online services, and knows a range of ways to report concerns. | • Makes judgements about digital content when evaluating and repurposing it for a given audience. **(EV) (GE)**<br>• Recognises the audience when designing and creating digital content. **(EV)**<br>• Understands the potential of information technology for collaboration when computers are networked. **(GE)**<br>• Uses criteria to evaluate the quality of solutions, can identify improvements making some refinements to the solution, and future solutions. **(EV)** |
| **(purple)** | • Understands that iteration is the repetition of a process such as a loop. **(AL)**<br>• Recognises that different algorithms exist for the same problem. **(AL) (GE)**<br>• Represents solutions using a structured notation. **(AL) (AB)**<br>• Can identify similarities and differences in situations and can use these to solve problems (pattern recognition). **(GE)** | • Understands that programming bridges the gap between algorithmic solutions and computers. **(AB)**<br>• Has practical experience of a high-level textual language, including using standard libraries when programming. **(AB) (AL)**<br>• Uses a range of operators and expressions e.g. Boolean, and applies them in the context of program control. **(AL)**<br>• Selects the appropriate data types. **(AB)** | • Knows that digital computers use binary to represent all data. **(AB)**<br>• Understands how bit patterns represent numbers and images. **(AB)**<br>• Knows that computers transfer data in binary. **(AB)**<br>• Understands the relationship between binary and file size (uncompressed). **(AB)**<br>• Defines data types: real numbers and Boolean. **(AB)**<br>• Queries data on one table using a typical query language. **(AB)** | • Recognises and understands the function of the main internal parts of basic computer architecture. **(AB)**<br>• Understands the concepts behind the fetch-execute cycle. **(DE) (AB)**<br>• Knows that there is a range of operating systems and application software for the same hardware. **(AB)** | • Understands how search engines rank search results. **(AL)**<br>• Understands how to construct static web pages using HTML and CSS. **(AL) (AB)**<br>• Understands data transmission between digital computers over networks, including the internet i.e. IP addresses and packet switching. **(AL) (AB)** | • Evaluates the appropriateness of digital devices, internet services and application software to achieve given goals. **(EV)**<br>• Recognises ethical issues surrounding the application of information technology beyond school.<br>• Designs criteria to critically evaluate the quality of solutions, uses the criteria to identify improvements and can make appropriate refinements to the solution. **(EV)** |
| **(red)** | • Understands a recursive solution to a problem repeatedly applies the same solution to smaller instances of the problem. **(AL) (GE)**<br>• Recognises that some problems share the same characteristics and use the same algorithm to solve both. **(AL) (GE)**<br>• Understands the notion of performance for algorithms and appreciates that some algorithms have different performance characteristics for the same task. **(AL) (EV)** | • Uses nested selection statements. **(AL)**<br>• Appreciates the need for, and writes custom functions including use of parameters. **(AL) (AB)**<br>• Knows the difference between, and uses appropriately, procedures and functions. **(AL) (AB)**<br>• Understands and uses negation with operators. **(AL)**<br>• Uses and manipulates one dimensional data structures. **(AB)**<br>• Detects and corrects syntactical errors. **(AL)** | • Understands how numbers, images, sounds and character sets use the same bit patterns. **(AB) (GE)**<br>• Performs simple operations using bit patterns e.g. binary addition. **(AB) (AL)**<br>• Understands the relationship between resolution and colour depth, including the effect on file size. **(AB)**<br>• Distinguishes between data used in a simple program (a variable) and the storage structure for that data. **(AB)** | • Understands the von Neumann architecture in relation to the fetch-execute cycle, including how data is stored in memory. **(AB) (GE)**<br>• Understands the basic function and operation of location addressable memory.**(AB)** | • Knows the names of hardware e.g. hubs, routers, switches, and the names of protocols e.g. SMTP, iMAP, POP, FTP, TCP/IP, associated with networking computer systems. **(AB)**<br>• Uses technologies and online services securely, and knows how to identify and report inappropriate conduct. **(AL)** | • Justifies the choice of and independently combines and uses multiple digital devices, internet services and application software to achieve given goals. **(EV)**<br>• Evaluates the trustworthiness of digital content and considers the usability of visual design features when designing and creating digital artifacts for a known audience. **(EV)**<br>• Identifies and explains how the use of technology can impact on society.<br>• Designs criteria for users to evaluate the quality of solutions, uses the feedback from the users to identify improvements and can make appropriate refinements to the solution. **(EV)** |
| **(black)** | • Recognises that the design of an algorithm is distinct from its expression in a programming language (which will depend on the programming constructs available). **(AL) (AB)**<br>• Evaluates the effectiveness of algorithms and models for similar problems. **(AL) (AB) (EV)**<br>• Recognises where information can be filtered out in generalizing problem solutions. **(AL) (AB) (GE)**<br>• Uses logical reasoning to explain how an algorithm works. **(AL) (AB) (DE)**<br>• Represents algorithms using structured language. **(AL) (DE) (AB)** | • Appreciates the effect of the scope of a variable e.g. a local variable can't be accessed from outside its function. **(AB) (AL)**<br>• Understands and applies parameter passing. **(AB) (GE) (DE)**<br>• Understands the difference between, and uses, both pre-tested e.g. 'while', and post-tested e.g. 'until' loops. **(AL)**<br>• Applies a modular approach to error detection and correction. **(AB) (DE) (GE)** | • Knows the relationship between data representation and data quality. **(AB)**<br>• Understands the relationship between binary and electrical circuits, including Boolean logic. **(AB)**<br>• Understands how and why values are data typed in many different languages when manipulated within programs. **(AB)** | • Knows that processors have instruction sets and that these relate to low-level instructions carried out by a computer. **(AB) (AL) (GE)** | • Knows the purpose of the hardware and protocols associated with networking computer systems. **(AB) (AL)**<br>• Understands the client-server model including how dynamic web pages use server-side scripting and that web servers process and store data entered by users. **(AL) (AB) (DE)**<br>• Recognises that persistence of data on the internet requires careful protection of online identity and privacy. | • Undertakes creative projects that collect, analyse, and evaluate data to meet the needs of a known user group. **(AL) (DE) (EV)**<br>• Effectively designs and creates digital artefacts for a wider or remote audience. **(AL) (DE)**<br>• Considers the properties of media when importing them into digital artefacts. **(AB)**<br>• Documents user feedback, the improvements identified and the refinements made to the solution. **(AB)**<br>• Explains and justifies how the use of technology impacts on society, from the perspective of social, economical, political, legal, ethical and moral issues. **(EV)** |
| **(white)** | • Designs a solution to a problem that depends on solutions to smaller instances of the same problem (recursion). **(AL) (DE) (AB) (GE)**<br>• Understands that some problems cannot be solved computationally. **(AB) (GE)** | • Designs and writes nested modular programs that enforce reusability utilising sub-routines wherever possible. **(AL) (AB) (GE) (DE)**<br>• Understands the difference between 'While' loop and 'For' loop, which uses a loop counter. **(AL)**<br>• Understands and uses two dimensional data structures. **(AB) (DE)** | • Performs operations using bit patterns e.g. conversion between binary and hexadecimal, binary subtraction etc. **(AB)**<br>• Understands and can explain the need for data compression, and performs simple compression methods. **(AL) (AB)**<br>• Knows what a relational database is, and understands the benefits of storing data in multiple tables. **(AB) (GE) (DE)** | • Has practical experience of a small (hypothetical) low level programming language. **(AB) (AL) (DE) (GE)**<br>• Understands and can explain Moore's Law. **(GE)**<br>• Understands and can explain multitasking by computers. **(AB) (AL) (DE)** | • Understands the hardware associated with networking computer systems, including WANs and LANs, understands their purpose and how they work, including MAC addresses. **(AB) (AL) (DE) (GE)** | • Understands the ethical issues surrounding the application of information technology, and the existence of legal frameworks governing its use e.g. Data Protection Act, Computer Misuse Act, Copyright etc. **(EV)** |

**Computational Thinking Concept:** AB = Abstraction; DE = Decomposition; AL = Algorithmic Thinking; EV = Evaluation; GE = Generalisation

**COMPUTING AT SCHOOL**
EDUCATE · ENGAGE · ENCOURAGE
In collaboration with BCS, The Chartered Institute for IT