**What is abstraction?**

For American computer scientist Jeanette Wing, credited with coining the term, abstraction lies at the heart of computational thinking:

> "The abstraction process – deciding what details we need to highlight and what details we can ignore – underlies computational thinking." *Computational thinking and thinking about computing (The Royal Society, 2008)*

Abstraction is about simplifying things; identifying what is important without worrying too much about the detail. Abstraction allows us to manage complexity.

We use abstractions to manage the complexity of life in schools. For example, the school timetable is an abstraction of what happens in a typical week: it captures key information such as who is taught what subject where and by whom, but leaves to one side further layers of complexity, such as the learning objectives and activities planned in any individual lesson.

<table>
<thead>
<tr>
<th>Caterpillar class</th>
<th>Monday</th>
<th>Tuesday</th>
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<tbody>
<tr>
<td>Time</td>
<td>Registration</td>
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<td>8:50 to 9:00</td>
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<td>9:00 to 10:00</td>
<td>English</td>
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<tr>
<td>10:00 to 10:20</td>
<td>Playtime</td>
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<tr>
<td>10:20 to 10:30</td>
<td>Class time</td>
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<tr>
<td>10:30 to 11:30</td>
<td>Maths</td>
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<tr>
<td>11:30 to 12:00</td>
<td>Phonics</td>
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<tr>
<td>12:00 to 1:00</td>
<td>Lunchtime</td>
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<tr>
<td>1:00 to 2:15</td>
<td>Topic</td>
<td>PE (small hall)</td>
<td>PE (large hall)</td>
<td>PPA subjects</td>
<td>Topic</td>
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<tr>
<td>2:15 to 3:15</td>
<td>Topic</td>
<td>Singing Assembly</td>
<td>Topic</td>
<td>PPA subjects</td>
<td>School Assembly</td>
</tr>
</tbody>
</table>

A class timetable is an abstraction of the school day for one class, much is omitted to provide a simplified summary.

**Why is abstraction important?**

Abstractions are sometimes represented as layers or hierarchies, allowing us to view things at different degrees of detail. The nature of being able to hide complexity within boxes within boxes makes abstraction a powerful tool as we do not need to worry about the technical detail of what goes on inside each box.

In computer science, abstraction is used to manage the complexity of much of what is designed and created. Computer hardware is seen as components or black boxes. Software is built of layers each hiding the complexity of the next successive layer.
What does abstraction look like the primary curriculum?

The national curriculum for computing in England leaves abstraction until key stage 3, although it is part of the overarching aims of the subject, which seeks to ensure that all pupils:

"can understand and apply the fundamental principles and concepts of computer science, including abstraction, logic, algorithms and data representation."

Abstraction is such a powerful way of thinking about systems and problems that it seems worth introducing pupils to this whilst they’re still at primary school. This doesn’t have to be just in computing lessons.

- In maths, working with ‘word problems’ often involves a process of identifying the key information and establishing how to represent the problem in the more abstract language of arithmetic, algebra or geometry.
- In geography, pupils can be helped to see a map as an abstraction of the complexity of the environment, with maps of different scales providing some sense of the layered nature of abstraction in computing.
- In music, the piano score of a pop song might be thought of as an abstraction for that piece of music.

When creating a story plan, a summary, or working out a mind map pupils are abstracting, as they are leaving to one side the detail they do not need at that time.
Simulations and models are abstractions: these are used across the curriculum to explain ideas. For example, science simulations might help to teach about gravity, history simulations about the Roman invasion of Britain, physical geography models give insights about how fossilization occurs, art simulations might show how to work with clay, data handling models allow exploration of what if scenarios and so on. Also beyond the curriculum simulations and models are the basis of most computer games.

In computing lessons, pupils can learn about the process of abstraction from playing computer games, particularly those that involve interactive simulations of real world systems as they appreciate that they are based on, but simpler than real life. Encourage pupils’ curiosity about how things work, helping them to think about what happens inside the computer or on the internet as they use software or browse the web.

**EYFS**

In early years, there are many opportunities for pupils to start to summarise. Pupils are asked to recount events and so start to think about what is important and how to create a summary. When counting they start to sense an understanding of the abstraction of number, as they count three bears, three bricks, three friends and formulate an abstraction of ‘threeness’.

**KS1**

*Use logical reasoning to predict the behaviour of simple programs.*

In KS1 pupils continue to explore abstraction. They start to explore viewpoints in history as they role play famous people. They study maps in geography learning how to add places of interest and ignore detail. They use world maps and create local maps and so start to see different layers of abstraction. Written forms of abstraction become more common, for example, they abstract in literacy when they create a plan of a story; in science, when they make make notes and charts as they identify what is the most important property of a material to make it suitable for a particular purpose.

**KS2**

At KS2, pupils continue to simplify and summarise and in so doing become more experienced in abstraction. They reflect on what they know or have learned and create summaries, for example in pre and post topic assessments, recording the most important facts and so creating an abstraction of their understanding. Pupils may start to consider the level of detail in summaries they create. For example, they may add more detail to a story plan as they write.
When presenting reports or arguments, they consider what are the most significant aspects, they summarise their findings in science, they compare geographical aspects over time, and contrast historical events. As they put together a presentation or video on a topic they know about, they’ll need to focus on the key information, and think about how this can be represented, whilst leaving to one side much of the detail of the subject: this too involves abstraction.

Pupils can look at maps of varying scales as abstractions of the real world. Or they might consider a period in history at global, national, local and even individual levels.

When learning about technical aspects of computers, pupils use abstractions that hide much of the detail, such as when learning about the internet, data representation or algorithms. They learn at a summary level first and then add detail as they look inside the ‘black boxes’ and find out more. They learn to see components of a computer or a system as ‘black boxes’, hiding the underlying complexity.

They may role play the internet, creating an abstraction of this complex network of cables, hardware and software. Encourage pupils who are learning to program to create their own games or simulations. Ask them to think really carefully about what detail they need to include, and what can be left out.

For example, an animation of the water cycle includes only the key steps at ‘big picture’ level, ignoring much of the complexity of the real world.
Find out more about abstraction
Further examples of abstraction
A note about abstraction and decomposition
BBC Bitesize, ‘Abstraction’
BBC Cracking the Code, ‘Simulating the Experience of F1 Racing Through Realistic Computer Models’
Thinking about myself – abstraction
Google games – puzzle