Looking to the future

Welcome to iBYTES
– a free and exclusive teaching resource from OCR

For teachers and students of GCSE ICT and GCSE Computing, *iBYTES* provides interesting and topical content to enrich learning, both in and out of the classroom.

Issue 8

iBYTES

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Imagine the future . . .

Your journey to work is in an electric powered car that needs no charging from your home and there is no limit to the range your car can travel, as it doesn't need to be charged prior to a journey. During your journey, the car communicates with other vehicles on the road as well as with the traffic system, so when there is a traffic jam on the road in front of you, warning lights light up on the dash board to tell you of the danger up ahead of slow traffic. Cruise control can automatically adapt your speed by communicating with vehicles on the road up ahead, so if you approach heavy traffic the car automatically slows down, reducing the risk of an accident. Your car can communicate with traffic lights, so if the road is clear but the traffic lights are red, the car can communicate this to the lights so that they turn green; the car can also automatically stop at traffic lights that are changing to red, so that you don't go through the lights on red. When you approach a toll road, there is no need to stop and pay, as a device inside your car is detected by the toll system and payment is deducted automatically. This all adds up to a safer, easier journey to work.

In your leisure time you enjoy shopping and watching sport, as well as communicating with your friends. You use your smartphone to go online to buy an item of jewellery and you're able to customise the item you choose, as the retailer will use a 3D printer to produce your jewellery to order. Not only that, you're able to buy food that has been produced using a 3D printer.

When you go to the supermarket to do the weekly shop, there is no need to go to a till to pay for your shopping – every time you put an item in your shopping trolley it is automatically recognised and the total amount of your bill is deducted directly from your bank account as you walk out of the shop. When you throw away an empty food packet at home, your fridge tells you that you need to buy more of that product next time you go shopping, so there is no forgetting to buy that all-important food item and having to go back to the supermarket.

Out and about, you can photograph and video the world around you without using your camera or phone and you automatically connect to friends through social media. You can browse the web without getting your smartphone or tablet out of your bag, and you can navigate to where you want to go by listening to a voice guiding you along the streets that you can see in front of you.

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Emerging technologies

We don't need to imagine this as our future – it is very possible that our lives will be very much like this before too long, due to emerging technologies.

The World Economic Forum's Global Agenda Council on Emerging Technologies defines emerging technologies as those that *"have made development breakthroughs and are nearing large-scale deployment"*

www.weforum.org/content/top-10-emerging-technologies-2013

In other words, it is a technology that already exists or is being developed and will soon be widely used.

So what are some examples of emerging technologies in 2013?

Transport: OLEV (OnLine Electric Vehicles), Remote sensing, RFID

Sport: Hawk Eye goal line technology used in tennis, cricket and now football, for the first time this season

Leisure and everyday life: RFID tags, Google Glass

Manufacturing and retail: 3D Printing

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How emerging technologies are affecting our lives

RFID Tags

The original RFID tags were simply used to track items, by scanning the tag with a reader which identified a specific tag – usually used on cattle or luggage on aeroplanes (not to be confused with an electronic tag used to monitor a criminal's position using GPS).

These first RFID tags were made of inductively coupled metal coils, antennae and glass. Since these original tags, disposable 'capacitively coupled tags' used conductive carbon ink printed on paper to hold data. Newer RFID tags are made up of a microchip, antenna and sometimes a battery, enclosed in plastic. There are 3 types of these new RFID tags: Passive, Semi-passive and Active tags. Active and Semi-passive tags can be read 100 metres or more away from a reader and are more expensive, whilst Passive tags can be read up to 20 metres away and are cheaper and disposable. An RFID tag's price is also determined by its ability to read and write data – a read/write tag can have data added to it or over-written, whereas a read-only tag cannot have data added; a WORM tag can have data written to just once.

RFID tags nowadays are used to track our luggage on airlines, help identify lost pets, track vehicles going through toll stations, track Alzheimer's patients and also track merchandise in the retail industry. RFID tags can have read/write capabilities, so that data on them can be read and also updated – this means that an RFID tag on a car windscreen can charge the toll fee automatically to the user's account.

RFID tags in pets carry information about the owner – their name and contact details – so that if a lost pet is found, it can be scanned with a reader by a vet to find out the owner. A chip the size of a grain of rice is injected into the animal's neck.

RFID tags can be used on people such as those suffering from Alzheimer's and can carry medical information which can be read at a hospital to gain information on a patient's condition. They can also be used in ankle bracelets on newborn babies so that readers at the hospital exits can sound an alarm if an unauthorised person tries to remove a baby from the hospital.

A phone charm has been developed in Japan which uses an RFID tag to store an owner's medical history. This means that if the owner was involved in an accident or had a medical emergency, the hospital staff would be able to gain personal medical information quickly by scanning the phone charm.

In the future, we're likely to see barcodes on food items we buy replaced with RFID tags. These will allow data to be read when an item is placed in a shopping trolley. The reader will be linked to a network so that the total price of your shopping can be directly deducted from your bank account, without the need to go through a till. The information will also be sent to the retailer, to enable them to know how much of an item is in stock, when to reorder and also to see consumer preferences. The tag would also be read when we throw an empty packet away, enabling data to be sent to our refrigerator which will then add this item to our shopping list.

Text adapted from **Howstuffworks.com http://electronics.howstuffworks.com/gadgets/high-tech-gadgets/rfid.htm**

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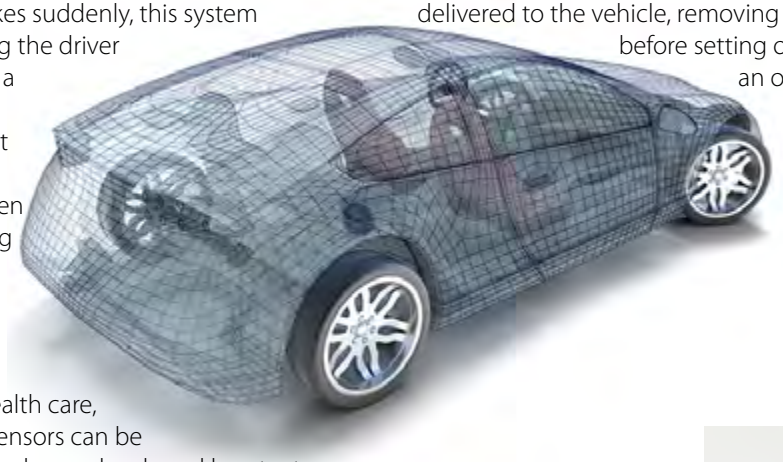
Remote Sensing

Car manufacturers such as Ford and Mercedes are working on remote sensing in vehicles that will allow cars to communicate with each other and also with their environment, to make the roads safer. One of these developments is a remote brake light system – if a car up in front, that you maybe cannot see because it is round a corner or the weather conditions have reduced visibility, brakes suddenly, this system will light up on the dashboard, warning the driver of the danger and, hopefully, avoiding a multiple pile-up. Cars will be able to communicate with traffic lights, so that the driver can be told if the next set of lights they approach will be red or green for the current speed they are travelling at; the system could also change the colour of the traffic lights depending on the traffic.



Remote sensing is currently used in health care, combined with wireless technology. Sensors can be used to measure functions such as blood sugar levels and heart rate and then send this data wirelessly to a device that can respond to the condition, such as delivering insulin to diabetics.

Text adapted from Mashable.com
http://mashable.com/2013/06/20/remote-brake-lights/

OLEV

One of the big disadvantages of electric cars at the moment is the limited range that they can travel on a full charge. Car manufacturer, Volvo, are developing a system called OnLine Electric Vehicles, or OLEV, where power lines are put into the road, so that when an electrically powered vehicle travels over the power lines an electric current is delivered to the vehicle, removing the need for a car to be recharged before setting off on a journey or for it to even have an onboard battery for a journey.

Google Glass

Google Glass isn't actually a pair of glasses, though it can have 'lenses' attached To make it look more like glasses. It is a way of seeing your data in front of you without the need to hold up your phone or tablet. It can also use augmented reality to overlay data on what you see, much like an augmented reality app on a smart phone that overlays data on top of Google maps . Google Glass consists of a camera, a display, a touchpad and a microphone. It also uses bone-induction technology to enable the wearer to hear sounds. Google Glass can be controlled either with gestures or with voice commands through the microphone. The device can be used to browse the web, send and receive emails, take photographs and videos and get directions. You can also use it to video conference with friends.

Web article

Web article

3D printing

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3D printing is combined with CAD (Computer Aided Design) to design and produce items for use in all walks of life. A design of the object is produced and then divided into digital cross-sections, which will be the layers that the printer will print. A main difference between 3D printing ar 'normal' manufacturing is that a 3D printer builds up the object in layers whereas an object manufactured in the usual way cuts bits off a material to leave the finished shape, meaning there is wasted material. Materials such as plastics, rubber, metals and paper can be used with a 3D printer. The chosen material is sprayed or squeezed onto a flat surface on the printer, by moving backwards and forwards to create layers. 3D printers have already been used to produce musical instruments , body parts, shoes and even guns. It's even possible that food could be produced using 3D printing.

EBay announced recently that it is going to launch a new iPhone app that allows you to view and customise items such as jewellery which will then be printed and sent to you.

Downsides of 3D printing yet to be resolved include copyright infringement – e.g. someone producing a design of a Disney character and printing it off, without getting permission from the copyright holder. There are also security issues – if someone can print off a gun, that could have huge implications for society where owners of guns need a license.

Text adapted from Mashable.com:

3d-printing-explained

Ebay 3d print phone app

Web article

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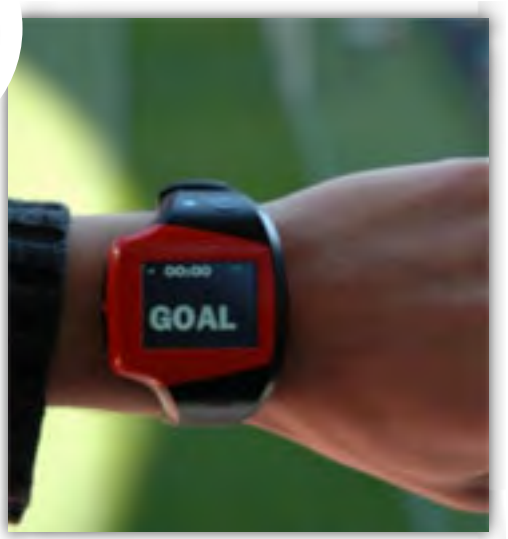

Hawk Eye goal line technology

'Hawk Eye' has been in use for cricket and tennis matches for a few years now, first appearing at Wimbledon in 2007 but this year it is being introduced to Premiership football for the first time. It works by having cameras situated around the ground. Each camera tracks the ball and can tell whether the whole of the ball has crossed a line. The outcome is transmitted almost immediately to the referee via a wrist sensor they are wearing. The system has been thoroughly tested and even when the ball is partially obscured by a player or poor weather conditions, the cameras can still detect where the ball is.

Web article

Web article

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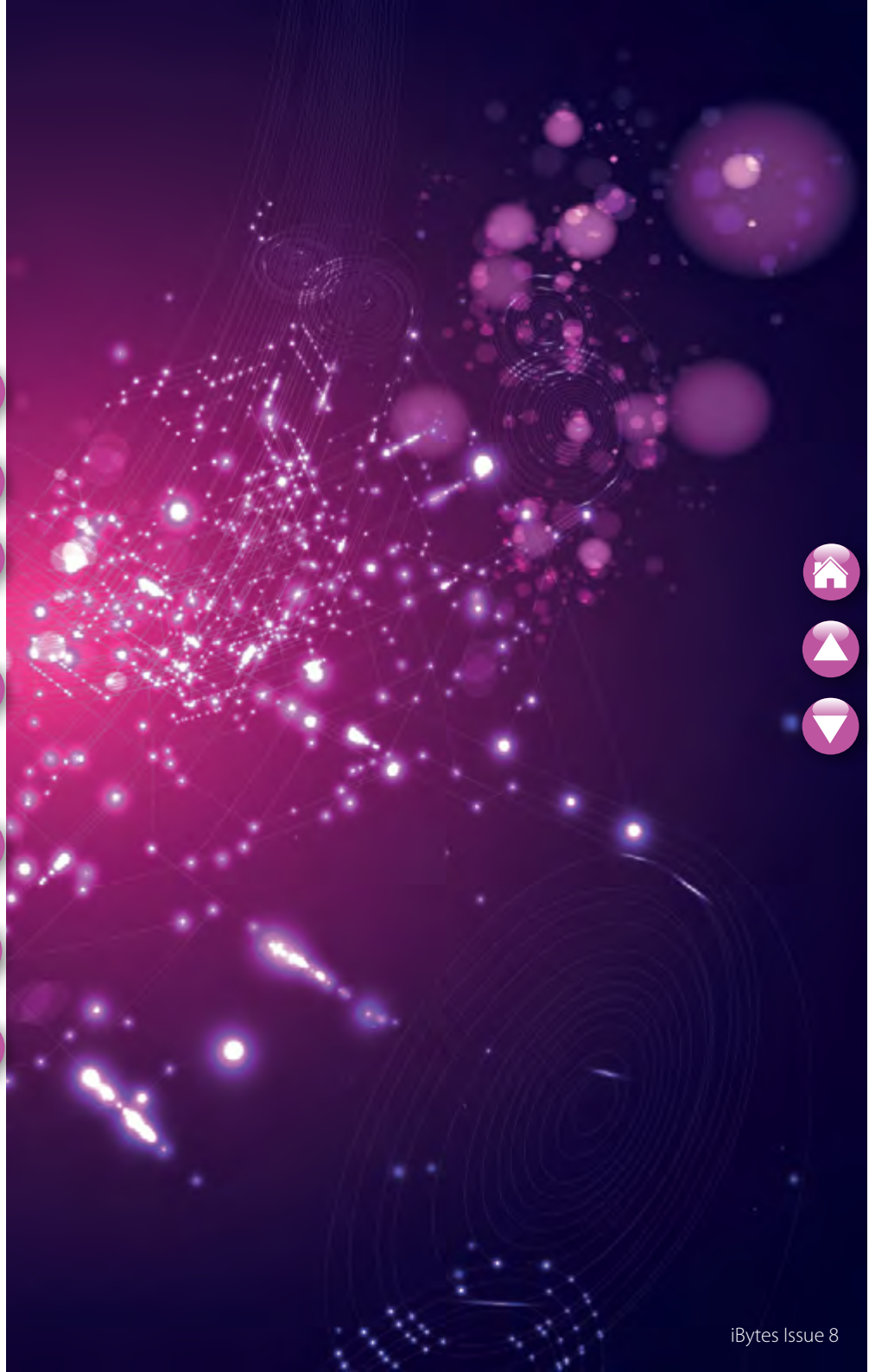
Teacher's Guide

Specification criteria map for GCSE ICT J461 and J061:

	Content Specification	Page number in specification
Exchanging information	2.1.2	7
Manipulating data	2.1.4	8
Keeping data safe and secure	2.1.5	9
Legal, social, ethical and environmental issues when using ICT	2.1.6	9
Monitoring, measurement and control technology	2.1.8	10
ICT and modern living	2.1.9	10
Current and emerging technologies	2.3.10	16



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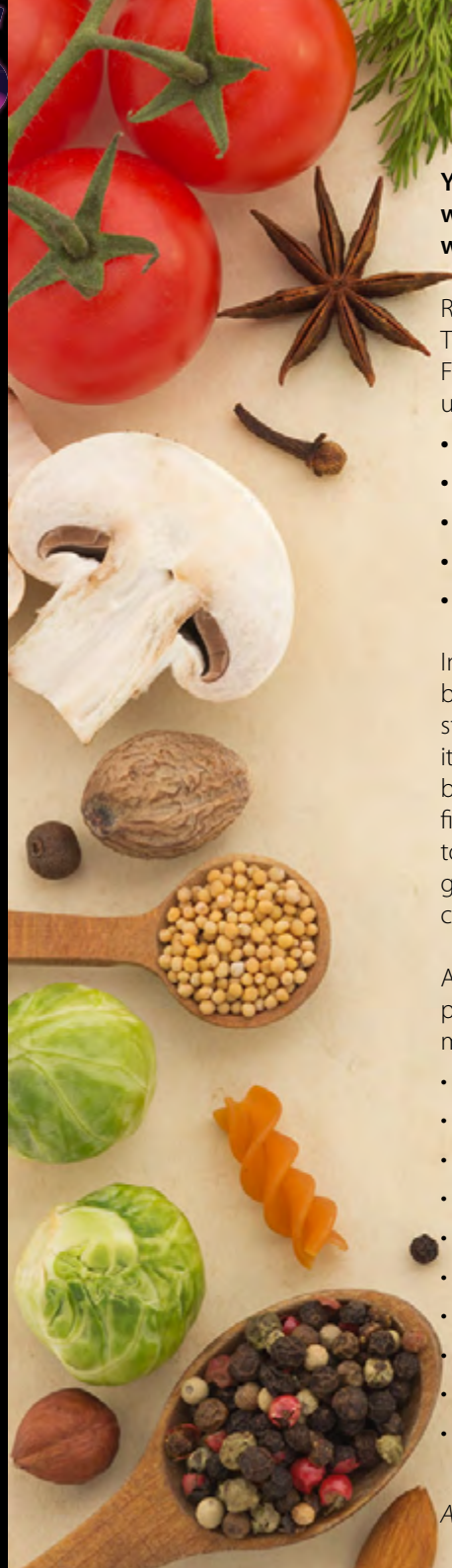


Computational thinking

You were probably once taught long division. You were taught how to do it as a series of steps. You were taught an algorithm.

Recipe books tell you how to produce a nice dinner. The steps are usually broken down to make it easier. For example, to make a pie, the process may be listed under the headings:

- **Gather the ingredients**
- **Cook the filling**
- **Make the pastry**
- **Fill the pie**
- **Bake the pie.**

In other words, the process of making a pie has been **decomposed** into a series of manageable steps. Sometimes the order matters and sometimes it doesn't. You can't bake the pie before it is filled but you might make the pastry before you cook the filling. It is often possible to work out the best order to do things. This is called **pipelining**. It might be a good idea to make the pastry early on so that you can chill it for easier rolling.

After this, each process is then described further to produce an **algorithm**. For example, '*Make the pastry*' might look like this:

- Weigh 250g flour
- Put the flour in a food processor
- Weigh 250g margarine
- Put margarine in the food processor
- Whizz the mixture
- Until it forms crumbs
- Add a few drops of water
- Pulse the mixture
- Until mixture is a single lump
- Roll mixture to shape required.

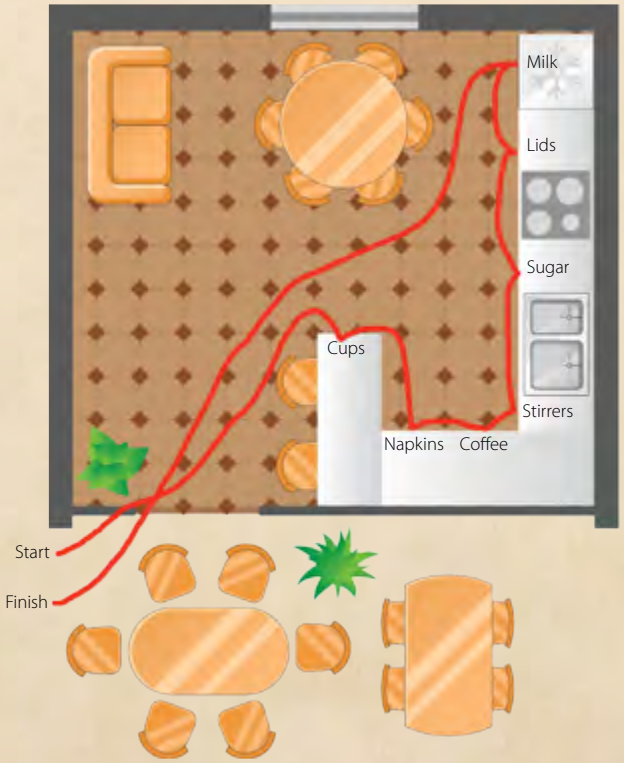
Adapted from Jeannette Wing lecture

You can see that this is looking more like an algorithm for writing a computer program. It has sequences and two loops. In fact, the overall approach to making a recipe is not that different from making an operating system. The scale is much bigger, but the ways of solving the problems are not that far apart from each other.

Now, most things we do in life can be approached in a similar way. We can borrow techniques and thought processes that have been developed by computer scientists and use them to help us do all sorts of jobs. This is particularly useful when we are doing complex things.

Consider the layout of a cafeteria where people go to collect their morning coffee. In this example, not enough thought has been put into it.

Route taken to get a coffee



How could thinking like a computer scientist improve the layout?

A computer scientist might apply the idea of pipelining to come up with a better design. This is a technique where the output of one process is made the input to the next.

Designing and building computer systems is not easy, because most of the component parts of a computer systems are abstractions or ideas. You can't pick up a function and hold it. Also, many systems are unlike anything that has gone before. Two basic questions need to be asked of any new system:

- Are we doing the right thing?
- Are we doing it right?

These difficulties have led to a new set of tools and rules in order to help developers produce the best products possible. The discipline of **software engineering** helps to make sure that new systems are as efficient and correct as possible.

Some jobs are not possible to do with computers. For example, it would be pretty handy if we had a computer program that could check any other program to see if it would always produce a correct result. No computer process exists to do this and what's more, it was proven long ago by Alan Turing that such a program **cannot** be produced.

It is only relatively recently that we have realised that the approach to problem solving used by computer scientists has huge implications for other aspects of life. This approach is called computational thinking.

Computational thinking includes the following characteristics:

- Analyzing and organizing data
- Pattern matching
- Data modelling, data abstractions, and simulations
- Formulating problems in such a way that computers can help us
- Identifying, testing, and implementing possible solutions
- Automating solutions via algorithms
- Generalizing and applying this process to other problems.

Looking at it another way, computational thinking involves a number of basic ideas:

- **Thinking abstractly**

This means making a model of a real world situation. It means dissecting out the essential features of a problem and ignoring what is not relevant. This can simplify a problem and also allow reuse of ideas that might apply to another problem. Thinking abstractly involves deciding whether a problem really can be solved. Is it possible to get the answer we need?

- **Thinking ahead**

Problems are best solved when you know at least some of the things you will need to complete the task. This can make use of past experience or even guesswork.

- **Thinking recursively**

This means that a problem or situation can be described in terms of itself. It allows a process to be repeated as often as is necessary to achieve a goal. For example, you could sort a list of names by the first letter, then by the second and so on until they are all in order.

- **Thinking procedurally**

This involves determining what steps are needed to solve a problem and in what order. It might mean that another procedure has to be called along the way.

- **Thinking logically**

This is determining what you can deduce from given facts. It is about being sure that 'y' follows from 'x' and not jumping to conclusions. Jumping to conclusions can be very useful in human life such as running away from an angry looking man who is holding a knife. He might only be Gordon Ramsay in his kitchen, but you don't want to spend ages logically working out all the possibilities. When designing systems, you need to understand connections more completely.

- **Thinking concurrently**

This is to do with deciding which parts of a problem can be solved at the same time and which are dependent upon previous processes being complete. This is necessary in order to produce the most efficient system possible.

Here are just a few examples of where computational thinking has had an impact.

Biology and medicine

The human genome has now been described. In other words, we now know the sequence of DNA bases that code for the construction of a human being. Recognition that DNA is digital information has revolutionised our understanding of genetics, disease and development. DNA sequencing has been made possible by the use of computational methods.

Computer science has also benefited from biology. Neural networks are clusters of computers that mimic human learning in the brain and allow machine learning to take place.

Artificial intelligence has learned from biology and brought numerous benefits ranging from predictive text on your phone, to language translators, to expert systems.

Statistics

Data mining is now commonly used to detect patterns that are not immediately obvious to humans. It involves looking through vast amounts of data from various sources. It has been used in astronomy to find new galaxies and in marketing to understand shoppers' habits.

Meteorology

Tornado formation can be better predicted using computational methods and, indeed, weather forecasting has much improved as our understanding of the atmosphere has benefited from the analysis of large amounts of data.

Society

Computational methods have led to improvements in

- detecting credit card fraud
- analysing shopping habits
- finding suitable movies/books/holidays for customers
- crime scene investigation
- targeting government policies and election campaigns
- advertising placement.

Sports

Computation has helped in improving sports coaching. Analysis of huge numbers of games can help coaches to find the right skills to push and importantly, which ones can be ignored.

The benefits of computational thinking are potentially enormous, especially if everyone becomes aware of its potential. Many think that computational thinking should be taught in schools as a fundamental skill as important as reading, writing and arithmetic.

In short, it helps us to:

- Understand what aspects of a problem can be tackled by computation
- Evaluate the match between computational tools and techniques and a problem
- Understand the limitations of computational tools and techniques
- Apply or adapt a computational tool or technique to a new use
- Recognise an opportunity to use computation in a new way
- Apply computational strategies such as to divide and conquer in any domain
- Apply new computational methods to their problems
- Reformulate problems to be amenable to computational strategies
- Make new discoveries through analysis of large data sets
- Ask new questions that were not thought of or dared to ask because of scale
- Explain problems and solutions in computational terms.

Jeannette Wing

The idea of computational thinking has been around for quite a long time. The term itself dates back to 1996 when it was coined by Seymour Papert – a pioneer of artificial intelligence.

However, in recent years, its huge importance and wide application has been clarified and energetically promoted by Jeannette Wing in the US.

Much of her work was undertaken while she was head of the Computer Science department at Carnegie Mellon University in Pittsburgh.

Thanks to her vision, it is now widely recognised that computing is about far more than devices. New computing courses are being devised, particularly in the UK, that promote this understanding. Jeannette herself acknowledged in an interview at the 2013 World Economic Forum in Davos, that the UK is at the forefront of these exciting developments.

Recently, Jeannette has moved to a position as Head of Microsoft Research International.

OCR has spearheaded the development of qualifications that place computational thinking at their heart, which will lead to great benefits for the students who achieve in them as well as the wider economy.

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Teacher's Guide

Specification criteria map for GCSE Computing J275:

	Content Specification	Page number in specification
2.1.1 Fundamentals of computer systems Define a computer system	2.1.1(a)	6
2.1.7 Programming Understand algorithms (written in pseudocode or flow diagram), explain what they do, and correct or complete them	2.1.7(a)	11
Produce algorithms in pseudocode or flow diagrams to solve problems	2.1.7(b)	11
Understand and use sequence in an algorithm	2.1.7(g)	11
Understand and use selection in an algorithm (IF and CASE statements)	2.1.7(h)	11
Understand and use iteration in an algorithm (FOR, WHILE and REPEAT loops)	2.1.7(i)	11
Describe syntax errors and logic errors which may occur while developing a program	2.1.7(p)	11
Understand and identify syntax and logic errors	2.1.7(q)	11

	Content Specification	Page number in specification
2.2.2 Effectiveness and efficiency		
Select suitable techniques for the development of their solution	2.2.2(a)	12
Use suitable techniques to solve all aspects of the problem	2.2.2(b)	12
Deploy practical techniques in an efficient and logical manner	2.2.2(c)	12
2.3.2 Design		
Analyse and identify the requirements for a solution to the problem	2.3.2(a)	15
Design suitable algorithms to represent the solution to a problem	2.3.2(b)	15
Design suitable input and output formats and navigation methods for their system	2.3.2(c)	15
Identify the data requirements for their system	2.3.2(d)	15
Identify suitable variables and structures with appropriate validation for their system	2.3.2(e)	15
Identify test procedures to be used during and after development to check their system against the success criteria	2.3.2(f)	15

Have you thought about Cambridge Nationals?

The Cambridge Nationals in ICT are vocationally related qualifications that take an engaging, practical and inspiring approach to learning and assessment. They are industry relevant, geared to key sector requirements and very popular with schools and colleges because they suit a broad range of learning styles and abilities.

Targeted at 14–16 year olds in a school environment, Cambridge Nationals in ICT are available as an Award (60GLH), Certificate (120 GLH), and Diploma (240 GLH), with the Certificate being the same size as a GCSE. The qualification is assessed using both internal and external assessment. The Certificate is included on the DfE Performance Tables for 2015.

The qualifications have been created to enable students to increase their knowledge in a progressive way. Each unit is synoptically linked, so the experience and skills gained in one unit will support learning in the next. Students have the freedom to explore more deeply the topics that interest them, as well as providing a good opportunity to enhance their learning in a range of areas.

Cambridge Nationals in ICT in brief

Core mandatory units for the Award, Certificate and Diploma:

- R001 - Understanding computer systems
- R002 - Using ICT to create business solutions

Optional units for the Certificate and Diploma:

Business strand (Diploma students must select one of these)

- R003 - Handling data using spread sheets
- R004 - Handling data using databases

Creative strand

- R005 - Creating an interactive product using multimedia components
- R006 - Creating digital images
- R007 - Creating dynamic products using sound and vision

Technical strand

- R008 - Introduction to computer programming
- R009 - Exploring computer hardware and networks
- R010 - Developing control systems

Student-initiated project R011 - Understanding technology – a project approach

This is ideal if you want to explore a theme further or pick up on a subject that isn't included. It's a student-initiated project that explores any subject in ICT in which the student may have a particular interest. They select, plan, manage and review their own project – it's problem solving at its best.

Find out more

To find out more about the Cambridge Nationals in ICT, visit the OCR website.

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Do you have a passion for a technological area? Do you have a lot of knowledge of this area? Do you think that you could write an **iBytes** document using that knowledge? We are on the lookout for imaginative and dynamic teachers to write **iBytes** documents. They should be informative, exciting to read and centred around a recent technological development. They should also strongly and visibly link to our **GCSE in ICT** or **GCSE in Computing** specifications.

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