Tapping in to the Inner Inventor

The Importance of Making in Computing

Inventing and making things is a great way to tap in to students' creativity and help them develop new skills that might seem overly technical or boring if they were taught out of context. Oliver Quinlan highlights some great initiatives that are inspiring students (and teachers) to develop their innate desire to create and invent.

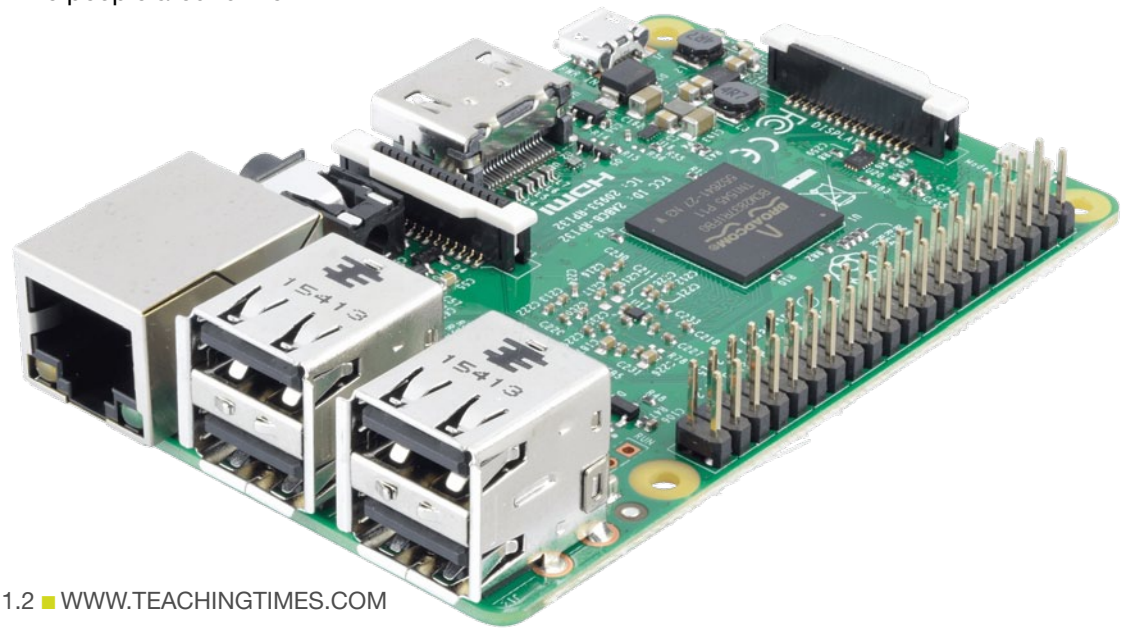
Back in 1739, Jacques de Vaucanson created and began exhibiting a new invention. Le Canard Digérateur or 'The Digesting Duck' was a machine made to imitate a real duck as closely as possible. Its wing alone was made of over 400 moving parts, and it could flap these wings, drink water, eat grain, and mimic the process of digestion all the way to the final event.

History is full of these kinds of inventions—to modern eyes they are strange but fascinating. They show the compulsion that people have had for hundreds of years to make, our need to create and invent. As David Orr says, 'We all begin life with a will to leave a mark no one else has left'.[1] We can see this in children from the earliest experiments with drawing and writing, to brick building and construction, through to teenage experiments with identity and fashion.

In recent years, the range of digital tools available to anyone to make has expanded enormously. While consumer devices such as tablets and laptops have become increasingly sealed and unrepairable boxes, a backlash against this has led to powerful technologies that young people can make with.

Devices such as the ‘Makey Makey’ allow even young children to get started creating powerful electronics that interface with a computer. The simple circuits with batteries and bulbs have made way for customised controllers for computer games. Low cost hardware devices, such as the Raspberry Pi computer and BBC micro:bit have allowed children to program their own hardware and create their own devices, with low barriers to entry programming languages such as Scratch, powering ideas both on screen and in the physical world.

Children and young people are using these technologies to make amazing things that address problems they and their communities face. Every year the Apps for Good awards showcases such projects. A stand out entry for me was a small group from Wick High School who created an app to help farmers in their community in Scotland to manage livestock information. These young people used their technology skills to create a product with real potential that serves a need for the people around them.



At the CoderDojo Coolest Projects event this year, I met children who were using their technology to make things they cared about. One group had set up a system to keep their house plants watered when they went on holiday using little more than a micro:bit and some small water pumps. Another pair of girls from Bulgaria had created a small robot that would follow them around to keep their possessions close by when they were playing in the local park. Others had created robots to carry heavy loads in the workplace, a system to help find missing persons in the background of photographs on social media and interactive stories to encourage girls to explore and challenge gender stereotypes.

There is a lot of discussion about the shortage of technology professionals, and the need for more young people to fill vacancies as professional programmers. It would be easy to think that learning computing and programming at school was just useful for people interested in this specialism. However, all of these projects show that programming and digital making skills can provide opportunities for young people to make solutions to problems in all sorts of areas of their lives.

To return to the Digesting Duck, it was put on display to the public and many people were wowed. It must have been fairly obvious that it was an artificial construction, but people could not understand how it worked. It would eat a mixture of water and seed and excrete a mixture of bread crumbs and green dye that really did look very authentic. The answer, unsurprisingly, was that it faked it. Hidden beneath the floor was a network of pipes and machinery that took in the seed and sent out some pre-digested seeds prepared earlier.

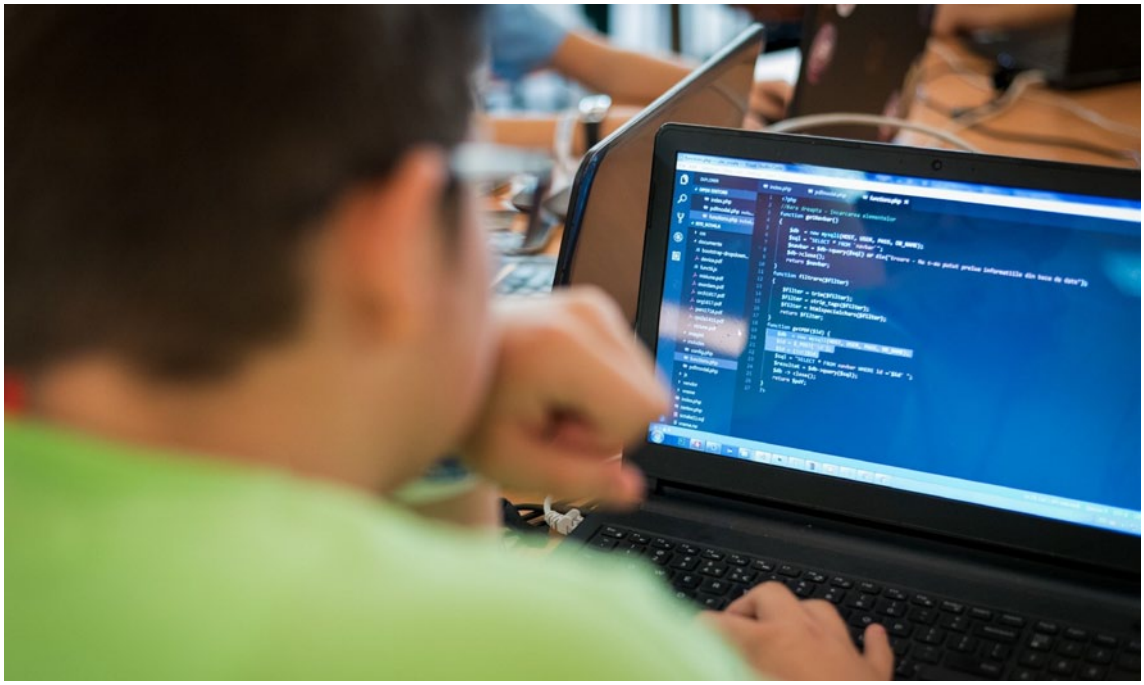
This anecdote really isn't that different to how most people see computers. We may joke about them being stupid when they don't quite behave as we want them to, but generally we perceive them to be very clever machines. How they reach this appearance is usually well hidden from observers, but fundamentally all they do is perform very basic maths. The

catch is that they can do this really, really fast. What they do is fundamentally something almost anyone could do, but they do it so many times, so quickly that is appears to be a different level of achievement. Computers can help us achieve amazing things, but only if we are able to express problems and processes for solving them in very particular ways.

Once you understand this concept, our technology-supported world really starts to look quite different. This is one of what Seymour Papert called 'powerful ideas' that can be used as 'tools to think with over a lifetime'. Once you realise that every seemingly amazing thing a computer does is just basic maths being performed very quickly, it becomes clearer that you can use a computer to achieve your own amazing things, if you just learn how to describe them in the right way. Papert was an educator who saw the early potential of computers and created the Logo programming language for children to explore them. He built on Piaget's theories that children need to work with ideas concretely early on before they can begin to explore them in a more abstract, intellectual way. What Papert saw in computers, and particularly simulations, was the potential for them to make concepts that are usually only accessible in an abstract way to be something children could manipulate concretely.

A familiar example of this is the 'Turtle Graphics' that many people know Logo for. Children type commands to an on-screen turtle and experiment with drawing shapes by making it move. In this way they can explore Geometry, building up concrete experience and a 'feel' for the mathematics behind it as well as discovering facts like the need for angles in a triangle to add up to 180 degrees. This experience is still a powerful one for children today, but more recent technology creates opportunities for all sorts of powerful ideas to be explored.

Perhaps the most powerful of these ideas is that all of the technology we used today was created by someone who is no



different to you. It may seen that technology is created behind closed doors by huge corporations, but much of it is really quite close to what young people can start to do themselves. The hit mobile game 'Flappy Bird' has made millions for it's creator since it was launched, and I've seen eight-year-olds creating their own version of it in a couple of hours using the Scratch programming language. Creating something that is part of their cultural world can show children that culture is not just to be received, but to be made and shaped by people like them.

Exciting opportunities like the Astro Pi competition allow children to engage with cutting edge contexts. Astro Pi encourages children to write code that will run on the International Space Station, using the same software and hardware that orbits the earth in the ISS laboratory. It's free to take part, starts off at a level beginners can access, and can build to creating science experiments which produce data collected in space for learners to analyse. This isn't make believe, it's real science taking place beyond the Earth. This

is the kind of experience that makes children see that their dreams of being astronauts really could turn into a future career in the space industry.

One final time I return to the Digesting Duck, because it also contains a powerful idea about making. These days we can tend to see making as something you learn how to do. We spend time in Design & Tech or Art learning the skills to make physical objects. In Music we learn how to make sound and in Computing we learn how to make things with computers. There is another way to see making, and that is as a way to explore and to learn. In 1789 no one fully understood how the digestive system of a duck worked, and so Jacques de Vaucanson tried to make one in order to learn about it in the process. His end product may have been lacking, and even laughable by modern standards, but in the process he managed to develop a technique to make the world's first flexible rubber hose. This invention has gone on to become a central part of medical systems across the world, allowing new techniques to be performed and lives to be saved.

Making is not just an avenue to learn particular skills or to know how to make particular projects. It is a way of learning in itself, a way of exploring the world, and understanding how real concepts work by engaging with them directly. Technology and computers bring tools for using making to engage with the real world, and explore powerful ideas that are important not just for our future software developers and programming experts, but for everyone.

Oliver Quinlan is Senior Research Manager at The Raspberry Pi Foundation. His book *The Thinking Teacher* helps teachers build deep and rich thinking into their teaching.
www.oliverquinlan.com

OPPORTUNITIES FOR COMPELLING MAKING

AstroPi: Write code that will run in space. Beginners can start with Mission Zero, older students can design their own experiments with Mission Space Lab. AstroPi.org
Apps for Good: A programme to encourage young people to design apps to solve social problems. appsforgood.org
CoderDojo: Free programming clubs where young people can create projects they care about. coderdojo.com
Coolest Projects: A technology fair where young people can showcase their projects. coolestprojects.org
Raspberry Pi Foundation projects: Games, websites, music, robots, digital art and more ideas for beginner makers projects. raspberrypi.org
Adafruit projects: Hardware projects for the more ambitious makers learn. adafruit.com

Notes:

1. Orr, D. (2010). Foreword. In O'Donnell Wicklund Pigozzi and Peterson, Architects Inc., VS Furniture., & Bruce Mau Design (eds.). *The third teacher: 79 ways you can use design to transform teaching & learning*. New York: Abrams.