SAPIENTIA

From ICT for Education

Everything you need to know about Computing, the curriculum, and the classroom

Welcome to the first issue in this academic year of Sapientia, ICT for Education's termly newsletter that provides education professionals with thought leadership, an insight into hot topics, and practical guidance on how to implement new technologies and techniques to improve teaching and learning.

This edition includes innovative ideas and activities that can be used in the classroom for student learning. The activities are relatively easy for teachers to instigate and students to use, and provide opportunities for creativity in computer science. They are also rather compelling.

An article on curiosity by Miles Berry, Professor of Computing Education at the University of Roehampton, discusses the advent of AI chatbots that provide an interactive style of learning close to personal tutoring. While not all students are curious enough to make use of these things themselves, Berry suggests that this is where schools can empower and motivate pupils to learn things for themselves, rather than just listening attentively to what is taught.

He moves on to provide three practical suggestions on how this could be done, including a shift in focus from theory and problems to projects, offering students music and gaming applications, and allowing them to tinker with code. Berry also promotes the use of questions in lessons to encourage curiosity in the classroom.

An article by Jo Brodie, Computer Science for Fun (CS4FN) at Queen Mary University of London, covers the creation of colour-by-number pixel puzzles by CS4FN and Teaching London Computing. The puzzles are fun to do and, after a little colouring, a picture starts to emerge. Educators can draw parallels with the way computers store images as numbers and can send images as a stream of numbers, and students engage in algorithmic thinking.

To celebrate the 50th anniversary of the Arecibo Message, a giant pixel puzzle that was sent into space on 16 November 1974 by the Arecibo Observatory in Puerto Rico but has yet to reach its destination of a star cluster about 25,000 light years from earth, Brodie is developing draft classroom activities based on the message and designed for both younger and older children. She concludes: “We hope our Arecibo activity packs will encode a sense of fun, and perhaps a sense of wonder too.”

To keep pace with the changes, challenges and opportunities in the primary and secondary education sectors, register for ICT for Education’s termly newsletter here or e.mail il@ictforeducation.co.uk.

Sarah Underwood, Editor - ICT for Education

Curiosity

By Professor Miles Berry, Professor of Computing Education at the University of Roehampton

My own primary education took place in an environment that was heavily influenced by the 1967 Plowden Report. Plowden’s committee favoured a more child-centred education, starting from the premise that ‘at the heart of the educational process lies the child’, rather than curriculum, exams or data. These days are long gone, but it is worth revisiting the report’s view that ‘One of the main educational tasks of the primary school is to build on and strengthen children's intrinsic interest in learning and lead them to learn for themselves’.

For the last couple of years of my primary school, one afternoon a week was given over to topic work, in which we would each choose a topic of our own to work on. I recall teaching myself about tea, local history, and, er, gambling. The process was more important than the content – this was the start of a life-long love of libraries and of the realisation that I could teach myself (almost) anything.

I doubt there would be many schools willing to take the risk of giving 10% of curriculum time to pupil-led learning, but some do. It's more common in nursery and reception than further up the school, but this comes back in the sixth form, with A Level coursework and EPQs. There's even a distant echo of Plowden's vision in Teachers' Standard 4, which requires all teachers to 'promote a love of learning and children's intellectual curiosity'.

This sort of independent learning is one way that pupils can move on from cheating with AI to use it to help with learning. The World Wide Web remains an amazing tool for a literate, connected and critical self-motivated learner, but it's not that different from learning in a library. AI chatbots change this, they provide an interactive style of learning close to personal tutoring. A teenager who asks ChatGPT to teach them about something can do more than read content: they can enter into a dialogue, ask follow-up questions, and answer the AI's own questions.

I'm impressed by the approach Sal Khan has taken with the Khanmigo, although much of this is available through general purpose tools such as ChatGPT, Gemini and Claude. Not all pupils are curious enough to make use of these things themselves, but this is where schools should do so much more: empowering and motivating pupils to learn things for themselves, rather than just listening attentively to what is taught. How might we do this? Here are three practical suggestions:

Shift the focus from theory and problems to projects. We shouldn't lose the underpinning theory of computer science or a problem-based approach, but I'd love to see much more project work happening. With younger learners, MIT's OctoStudio and Scratch offer so much scope for pupils to create their own games and animations, far richer in scope and content to what's in primary schemes of work. It's inspiring to see what young people have made in Scratch via its community site. Sometimes their code is a little 'smelly', but this seems a small price to pay for the evident enthusiasm and tenacity. This is harder with text-based programming, and step-by-step tutorials or toy problems don't quite capture the

magic of independent project work. Perhaps the trick is finding the right tool or platform?

For older pupils interested in music, Ear Sketch and Sonic Pi might work. I'm a huge fan of P5.js for creating interactive, visual art and am very pleased to see that the Python equivalent is supported by Raspberry Pi's new, online editor. For gamers, Pygame is okay as a starting point, but PC based Unreal Engine for Fortnite looks amazing. There's much more to computing than coding – media-based projects can be just as powerful a way in to independent learning.

Tinkering. Deliberately encourage pupils to experiment, explore and play with code, digital media and technology more generally. When introducing example programs, wait a while before going through them step by step and encourage pupils to figure them out for themselves, by reading the code, running it and then, crucially, through editing it to see how changes they make affect what it does.

You can take a similar approach to media tools – you don't have to demonstrate all the formats and filters yourself, and having pupils play with these helps build their curiosity. Scratch is a great source for examples - when young people share their work on Scratch, it's under an open licence that encourages others to remix the code.

Older pupils might start experimenting with open source code shared on Git Hub. Many who have gone on to do amazing things in and with tech share this willingness to tinker, to take an experimental approach to figuring out both how something works and what they can do with it. This is also a great strategy for debugging as there's more to this than just making changes until something works, rather it's about thinking through what might be causing the problem and then trying a fix for that.

Use questions to encourage curiosity. Think about how you use questions in your lessons, are these all about retrieval or checking for pupils' understanding? Or are you using them to get pupils thinking more deeply or more critically about things? From time to time, use questions to show your own curiosity. Make use of open questions, particularly if there are many possible answers. Harpaz and Lepstein describe 'fertile' questions as open, undermining, rich, connected, charged and practical. Fertile questions are great starting points for class discussion and some independent reading, as well as good preparation for longer exam questions. Once pupils

are used to working with questions like this, they can come up with their own examples too.

Make time in your lessons for pupils to ask questions, you're teaching a fascinating subject about which many of your pupils are eager to learn more. Don't be afraid of admitting if you don't know the answer to a question, instead model how you might find out, bounce questions back to the class, and follow up in a later lesson after you, and they, have had time to investigate.

Bringing out pupils' curiosity in class will make lessons more engaging, but it also motivates independent learning and equips pupils very well to make the most of all that AI now offers.

Register to meet and hear Miles speak at the ICTfE Salford Conference on October 10th at the AJ Bell Stadium. Plus a further opportunity at the ICTfE Birmingham Conference on November 8th at Villa Park.

Professor Miles Berry

Miles Berry is Professor of Computing Education at the University of Roehampton. Before joining Roehampton, he spent 18 years in schools, including a period as a head teacher. He has contributed to a wide range of computing projects, including the computing programmes of study in the National Curriculum, Barefoot Computing and Switched On Computing. He serves on the boards of Computing At School, the BCS Academy of Computing, and the National Centre for Computing Education, and is a regular keynote speaker and international consultant on curriculum and professional development. He is @mberry on Twitter and find out more on milesberry.net

Reach for the stars: Arecibo Message-

themed activity packs coming soon

By Jo Brodie, CS4FN, Queen Mary University of London

Back in April, at the ICT for Education conference held at Queen Mary University of London, I enjoyed my colleague Prof Paul Curzon's presentation about colouring in as a way to engage young people in learning computer science. Computer Science for Fun (CS4FN) and Teaching London Computing have created several colour-by-number pixel puzzles on squared paper for children and teachers to use. It's easy to grasp how it works, they're fun to do and after a bit of colouring a picture starts to emerge.

We have a whole range of them, all free, which you can download and print. We've even developed some you can colour in directly online if you don't have a printer. They can be used just as a thing to colour in, or as a learning tool.

The puzzles represent an image that is hidden until decoded. Each square is a pixel and it gets one colour that's set by the number printed in it. For example, anything with the number 4 should be coloured green and anything with a 5 should be coloured blue. Educators can draw parallels with the way computers store images as numbers and can send images as a stream of numbers. A child in your class could read a line of numbers to another and, provided they followed the colour code correctly and put each number into a consecutive square, they would end up with the identical line of colours – and easily transmittable algorithm. When satellites are sending back fantastic photographs (or any other data) from space, they're effectively sending them in much the same way.

After everyone's had a go, you might ask them how they approached it. Did they come to each new square and pick up the right coloured pen or pencil for that number or did they keep the same pencil in their hand until they'd coloured all the 4s in green? Did they go left to right, or top to bottom? Or pick a square and radiate out. Did they realise they were engaging in algorithmic thinking, or following a linear search?

In his talk, Paul also highlighted data compression, the use of spreadsheets for colouring online and gave examples of how you could also link this activity to other subjects. For example, art in terms of creativity in general and pointillism, or history considering the instructions for

Roman mosaics that could easily be transported, perhaps VI meant a purple-coloured tessera and so on.

Paul said later that he could have expanded further into binary and steganography and that's where I want to come in, with some activities we're creating to do with the Arecibo Message. Do you know what this image means?

On 16 November 1974, Frank Drake and his team at the Arecibo Observatory in Puerto Rico sent a giant pixel puzzle into space. It took three minutes to transmit the 1,679 bits of data that were carried on a powerful radio beam travelling at the speed of light. The puzzle was sent in the direction of M13, a star cluster about 25,000 light years from earth – it's yet to reach its destination though (only 24,950 years to go!).

If an intelligent species were able to receive the message via their own radio telescope, what might they make of it? All our pixel puzzles have been simple squares, typically 10x10 or 16x16, but 1,679 might not immediately suggest such an obvious grid pattern. However, that number is semi-prime, divisible by 23 and 73 and nothing else so two grid formations are possible, 23 x 73 or 73 x 23, but only one produces something that looks like a picture. To see the hidden (steganography) picture you'd have to decode the message three times: first as the binary signal; second to transpose it into the correct grid format, and third to make sense of the image that emerges.

To celebrate the 50th anniversary of the Arecibo Message on 16 November 2024, I've been developing some draft classroom activities that I hope teachers and their students will enjoy. You can see them as they're being added here teachinglondoncomputing.org/arecibo/, with plenty more coming soon. So far there's a simple pixel puzzle from a portion of the Arecibo Message for younger children. For older children, there's an opportunity to play with a comma-separated variable file and convert a series of 1s and 0s into a black and white image. Coming soon will be a version using Excel or Google Sheets with conditionally formatted presets to make the full colour version of the Arecibo message appear. You can see an example video here.

I also want to include a binary version of something similar to slow scan television (SSTV) in the activity packs, sending pictures by sound. Amateur radio

enthusiasts around the world regularly receive images sent from the International Space Station (ISS), transmitted as audible sound on a carrier radio wave, when the ISS passes overhead. Working with composer and programmer Sarah Angliss, we've created some bleeps and bloops to illustrate this in a fun way. Your class can listen to sound files and decode the 1s and 0s – perhaps it's an alien ReCaptcha! Hear an example here. Of course, you can transmit and receive binary data via any two-state system, not just sound, it could be by torchlight or flags, or just raising and lowering a bit of paper.

The original message wasn't really intended to communicate with aliens and no-one alive today will be around for any reply message – it was more to do with demonstrating the powerfulness of the transmitter's output after an upgrade. The actual message itself was sent at a frequency too high for humans to hear, but which the right device would easily decode, although for the launch event, the Arecibo engineers created a more audible version, which had quite an effect on the attendees: "When we sent the last character, and it stopped and we went back to that steady tone, everybody was crying," Dad says. "We were hearing what it would be like to actually contact another world. That was what that sound was. It had the aura of human beings doing something marvellous that involved the whole cosmos." (1)

We certainly hope our Arecibo activity packs will also encode a sense of fun, and perhaps a sense of wonder too. And, thanks to the team at the Planetary Habitability Laboratory at Arecibo, who are collating educational resources, some of our activities will also be translated into Spanish too. Contact us to find out more cs4fn@eecs.qmul.ac.uk

(1) 40 Years Ago, Earth Beamed Its First Postcard to the Stars (28 November 2014) National Geographic, Nadia Drake

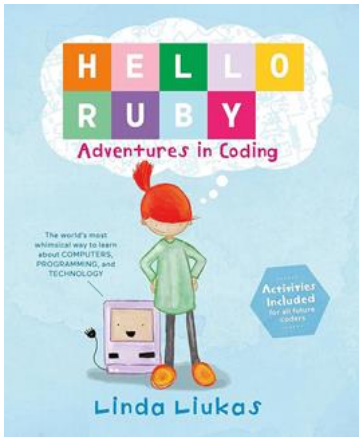
Joe Brodie

SC4FN, Queen Mary University of London

Jo Brodie is a science communicator on the Computer Science for Fun (CS4FN) and Teaching London Computing projects that support computing educators with resources, articles and classroom activities. She writes and edits articles for the CS4FN blog and magazines, and supports Paul Curzon's Engineering and Physical Sciences Research Council funded Public Engagement with ICT Champion through the CS4FN project.

Jo recently got her ham radio foundation licence so will probably be trying to talk to the astronauts on the International Space Station at some point (your class can apply too). She is also one of the organisers of the Charlton & Woolwich Free Film Festival, as seen in the accompanying photograph, introducing a lovely film that also briefly features a 1960s computer.

Recommended reading



Professor Miles Berry, of Computing Education at the University of Roehampton recommends:

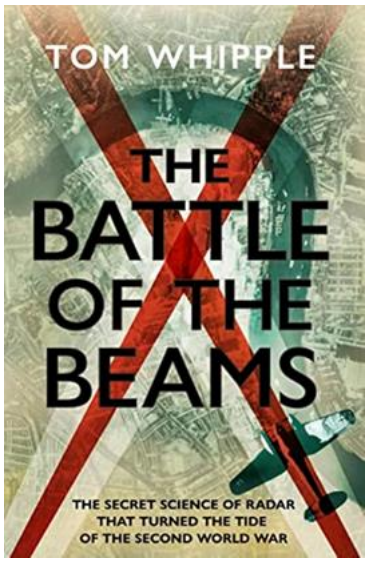
"Hello Ruby: adventures in coding" by Linda Liukas (Vol. 1). Macmillan.

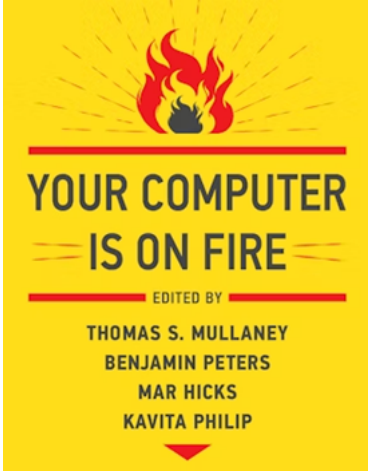
Half storybook, half activity guide, this book covers Ruby, a small girl with a huge imagination, and her adventures to discover some of the big ideas that underpin computing.

Miles also recommends:

"Agent Asha: mission shark bytes." by Sophie Deen and illustrated by Anjuan Sarkar from Walker Books..

A captivating story about young spy Asha Joshi and her use of coding to save the world.





Joe Brodie - SC4FN, Queen Mary University of London recommends:

"The Battle of the Beams" by Tom Whipple as an example of clever and life-saving things smart people did with radio waves (and aircraft) under phenomenal pressure during the 2nd World War

Relying on first-hand accounts as well as papers recently released by the Admiralty, The Battle of the Beams fills a huge missing piece in the canon of WW2 literature.

It combines history, science, derring do and dogged determination and will appeal as much to fans of WW2 history as to those fascinated by the science behind the beams that changed our lives.

"Your Computer is on Fire" a series of essays which highlight the variety of ways biases can be baked into software and computing culture. Interrogating how our human and computational infrastructures overlap, showing why technologies that centralize power tend to weaken democracy.

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