



THE ROYAL SOCIETY

After the Reboot: The State of Computing Education in UK Schools and Colleges

Annex 1: Case Study Schools

May 2017

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Contents

Acknowledgements.....	3
Introduction	4
Case Study 1. Alderley Edge School for Girls	7
Case Study 2. Bengeworth CE Academy	13
Case Study 3. Craigmount High.....	18
Case Study 4. East Barnet School.....	24
Case Study 5. Inverbrothock Primary School.....	29
Case Study 6. Kings Priory School	35
Case Study 7. Swanwick School and Sports College	40
Case Study 8. Western Primary School.....	44

Acknowledgements

Pye Tait Consulting would like to thank all primary and secondary schools/colleges that hosted case study visits. This includes teachers and students who contributed to meetings and discussions.

Your time and input to the research has been extremely valuable and is very much appreciated.

In addition we would like to thank The Royal Society and all members of the Computing Education Project Advisory Group for their help and support as part of the research.

Introduction

What is the research about?

In 2016, The Royal Society launched an important multi-strand programme designed to improve the quality, scale and effectiveness of computing education in schools and colleges across the UK. This consisted of three Work Packages:

1. A literature review of effective computing pedagogy and effective assessment of computing;
2. Quantitative and qualitative research among UK schools and colleges to examine the present state of computing education in schools; and
3. A baseline study on participation and attainment data.

The Royal Society commissioned Pye Tait Consulting to lead on Work Package 2, involving an online survey of schools and colleges, eight small discussion groups, and the development of eight written case studies of individual schools in England and Scotland¹.

The findings from the research informed the main project report for Work Package 2: *After the Reboot: The State of Computing Education in UK Schools and Colleges*. This document (an annex to the main report) presents the school case studies.

What is the purpose of the case studies?

The case studies set out to explore and document potentially transferrable best practice approaches to computing education. This takes into account schools' vision for the subject, the journey towards delivering a positive and engaging learning experience, and their top tips for success.

The case studies are intended to inform The Royal Society's work to develop potential project proposals based on evidence of approaches to teaching, learning and professional development that schools have found effective.

¹ The case studies focused on schools in England and Scotland only, reflecting the greater focus on computer science that has been introduced in those nations in line with curriculum requirements in recent years.

They are also intended to be of interest to anyone looking to find out more about how computing education is being delivered in a local setting, such as school/college teachers who may be looking to identify good practice for their own institution, as well as academics, parents, industry, professional bodies and societies, as well as members of the public.

Whilst each case study culminates in a short series of success tips aimed at other schools, the extent of transferability will inevitably be dependent on major factors such as funding, resourcing, staff professional development, partnership opportunities, and the value and importance placed on computing by the school as a whole.

How were schools selected?

Six of the case study schools were selected based on their responses to the preceding online survey, particularly those teachers who described being confident and favourable towards computing education, with a variety of activities and approaches in place to support local delivery. Two were selected based on suggestions put forward by Education Scotland.

How were the case studies developed?

Project team members at Pye Tait Consulting visited case study schools between December 2016 and January 2017. Each visited last about half a day and involved one-to-one interviews with relevant teaching staff (in some cases including Head teachers) as well as a small sample of students. The case studies were then written and approved by individual schools.

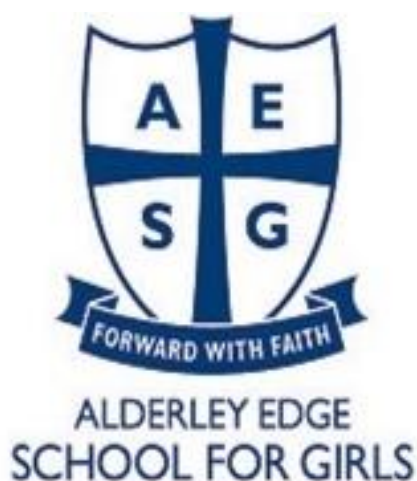
Which schools have been included?

Participating schools are listed alphabetically in Table 1.

Table 1: Case study schools

School name	Level of education	Location
Alderley Edge School for Girls	All-through	North West England
Bengeworth CE Academy	Primary	West Midlands
Craigmount High	Secondary	Scotland (City of Edinburgh)
East Barnet School	Secondary	London
Inverbrothock Primary School	Primary	Scotland (Angus)
Kings Priory School	Secondary	North East England
Swanwick School and Sports College	All-through	East Midlands
Western Primary School	Primary	Yorkshire and the Humber

Case Study 1. Alderley Edge School for Girls



Alderley Edge School for Girls (AESG) is a high-achieving, academic school in the North West of England. It educates girls aged between 2 to 18 within a positive and empowering environment, which encourages them to think creatively, aim high and play an active part within the school community.

The vision for computing education at AESG



Head teacher Helen Jeys' vision for computing education at AESG is one which effectively balances computer science, IT and the broader concept of digital literacy. The school currently offers GCSEs in both Computer Science and IT, and from September 2017 will be introducing a Computer Science A level. It has taught aspects of computer science since 2011, two years prior to the new curriculum being introduced in England.

Jamie Chadwick is Director of Technology Enhanced Learning at AESG. As a designated Computing at School (CAS) Master Teacher, Jamie supports other local schools to deliver computer science, and has developed close links with the University of Manchester. For Jamie, an increasingly technological society means that computer science should be taught alongside IT. To have the broadest appeal he believes that computing education is less about creating young people who are "*expert programmers*" and more about creating "*expert thinkers*".

Effectively delivering the new computing curriculum

Being prepared early and taking the time to get things in place has really helped AESG bring the new computing curriculum to life, with the biggest challenge being finding the time to create inspiring learning materials and being fully

prepared to deliver the content effectively.

At primary level, students have a creative learning ethos, and a programme of study called *Rising Stars* helps them to prepare for Key Stage 3. At secondary level, and to provide a joined up learning experience, students in Years 7, 8 and 9 repeat the same broad topic areas (programming, data representation, computer systems and online safety and security) year on year but with greater breadth and depth. To measure student progress, assessment takes place via tests at the end of each unit, leading up to formal internal exams in May and December. IT skills are taught within these units rather than as standalone projects, for example, image and sound editing skills are taught within the data representation unit.

"The curriculum needed to change. In a previous school I observed an IT lesson and noticed that the students already knew what they were being taught. They really wanted to know how the technology worked but it wasn't on the curriculum at the time."

Jamie Chadwick, Director of Technology Enhanced Learning

As part of the A level in Computer Science (being offered by AESG from September 2017), the school aims to help students develop the skills to solve problems, design systems and understand the power and limits of human and machine intelligence. Students will also learn the skills to analyse, critically evaluate and make decisions.

A supportive CPD environment for staff

AESG has nurtured a supportive atmosphere for Continuing Professional Development (CPD) across the school, which provides focus and encouragement for staff. Annual CPD meetings ensure the needs of individual teachers are identified and provide a forum for sharing knowledge and discussing ideas. In addition to CPD activities taking place in school hours (e.g. whole day events) staff are committed to investing some of their own time.

Specifically in relation to computing, AESG has found CAS resources to be particularly useful to support CPD, including regional CAS Hub meetings, along with support available from the Computer Science department at the University of Manchester.

Links with industry

A number of valuable links have been formed with industry to support computing education at AESG. Cloud service company, UKFast, has provided expert support as part of Year 6 code clubs, and the school has also sent students on work placements to the company. As Debbie Dawson, AESG's Director of Development, highlights – *"the students become interested and engaged when they can relate computing to the real world and to real occupations"*.

"It's great to work with a company like that who are really up for getting involved in schools and who have a strong corporate and social responsibility ethos. They are trying to show that it's fun to work in tech and that there's a diverse workforce."

Jamie Chadwick, Director of Technology Enhanced Learning

Other industry-focused initiatives that AESG has tapped into include:

- The National Cyber Security Challenge, a GCHQ competition to find the best and brightest candidates to protect the nation from future cyber-attacks;
- IET Faraday Challenge Days, which give students the opportunity to research, design and make prototype solutions to genuinely tough engineering problems. At each event teams compete to win a prize for themselves and a trophy for their school;
- EDT Go4Set, which links teams of six Year 8/9 (England) and S2 (Scotland) pupils with employers and universities to offer a 10-week Science, Technology, Engineering and Mathematics (STEM) Project;
- The Barclays *IT Girls Allowed* event, designed to demonstrate that computing careers are accessible to girls and to inspire them to consider this as a subject choice in the short term, and as a career choice in the long term. The event is aimed at students in Years 8 and 9, and activities have included insights into cryptography, programming robots, design and hardware.

The pros and cons of technology enhanced learning

AESG has an ambitious school-wide technology enhanced learning strategy which has developed alongside the changes to the computing curriculum. Increased use of technology across the school, especially use of tablets, has led Helen to reflect on the benefits and drawbacks. This has helped when promoting

increased technology use to parents and alleviating any concerns they may have. One such concern has been the risk of students being distracted by social media, making it important that the school has appropriate content filtering installed. Going forward, the school is setting up courses and open days for parents, to raise awareness on the topic and to answer any questions.

Jamie mentions that the use of tablets has been hugely empowering for both staff and students at AESG, describing them as "*agile task setters*". For example, programs such as iTunes U enables students to broaden and enhance their reading, while Airdrop allows them to take photographs of their cheek cells for display on a class screen, thus bringing Biology to life and out of the textbook.

Embedding technologies across different subject disciplines helps AESG students to become active and discerning users, in turn strengthening their digital literacy skills. Tablets are used to facilitate 3D printing and textile design, while augmented reality programs are used in science to undertake virtual heart dissections. In PE, computing is used for performance analysis, including motion statistics.

What the students say

The girls at AESG have shown great enthusiasm for computing, students describe their computing teachers as encouraging and helpful, but also that the teachers challenge them to work out computational problems for themselves. Rebecca (Year 9) feels that what she's learned in computing will provide a "*leg up*" to advanced computing, either at university or in work, and Lily (also Year 9) says that "*nearly every job has an element of computing or algebra*".

Some of the girls recognise where computing could help them in their future career plans, with Sophia (Year 8) wanting to become a forensic scientist and Lucinda (Year 11) thinking about studying quantum computing at university.

"Computing is really interesting and I think it's relevant to the real world."

Rebecca, Year 9

"Computing helps me to solve problems in maths."

Sophia, Year 8

In terms of more difficult aspects, Nicole (Year 7) mentions that it can take a long time to achieve the desired results from coding, which can at times be

frustrating. Lily (Year 9) and Aditi (Year 10) have found the written aspects more difficult than the practical work.

AESG's tips for success

- ✓ Talk to senior leaders in the school to ensure they understand and appreciate the value of computing. This is very important to stimulate investment in infrastructure, hardware and support for staff professional development, especially IT teachers who might need to make the transition to computer science;
- ✓ Don't underestimate the importance of good subject knowledge and investing one's own time in getting up-to-speed and developing the confidence to teach computing;
- ✓ Remember that computing is not just for certain types of students. Where a variety of creative learning approaches are offered, the subject can have a very broad appeal, including for girls as well as boys;
- ✓ Computer science and IT can be taught in harmony, for example by making more use of IT across other subjects to create the timetabled space for dedicated computer science lessons.

Case Study 2. Bengeworth CE Academy



Bengeworth CE Academy
An Outstanding Church of England School

Located in Worcestershire, Bengeworth CE Academy inspires pupils through imaginative approaches to teaching. Staff continually evaluate, refine and adapt the curriculum content to ensure that the school's roll of more than 450 pupils (Reception to Year 5) fully understand and enjoy what they learn.

Computing at Bengeworth CE Academy

Head teacher David Coaché has ambitious plans for computing at Bengeworth, and the vision is to be at the cutting edge of technological change so that pupils are ready for whatever may come next.

Aspects of computing are taught from Reception. In Years 1 and 2, pupils start to learn about e-safety, use iPads and cameras, and take their first steps in coding using Traffic Lights, Scratch Junior and Espresso. In Year 3, they learn how to use software effectively and make use of the Garage Band program to create musical accompaniments. By the end of Year 4 they can debug algorithms and create virtual games, leading to Year 5 where they practise coding and programming using a variety of software.

Bengeworth has also teamed up with Google to take part in a trial of its futuristic Google Expeditions virtual reality programme. This allows pupils to visit far-flung places without leaving the classroom, such as the Great Wall of China and even the time of the dinosaurs.

"Our aim is to embed computing in everything we do. It's about bringing pupils' learning and to life and preparing them for technologies and jobs in the future that might not even exist yet."

Greg Satterley, Year 4 teacher

Developing staff confidence to teach computing

Since joining Bengeworth little over a year ago in his NQT year, Greg has taken responsibility for curriculum development and assessment in computing. Natalie Snowdon (Year 2 teacher) has been instrumental in putting in place equipment and other resources, for example cloud-based systems and a new ICT suite. There is still work to do and a key area of focus has been building staff confidence in computing. This has involved increasing the amount of CPD, boosting confidence in equipment, as well as putting in place a clear curriculum and assessment framework.

"A lot of adults are scared of technology but the children don't have the fear factor and they can be more creative and will take risks. Where adults can get flustered if something doesn't work, children don't give up."

Natalie Snowdon, Year 2 teacher

Bengeworth uses a curriculum and assessment framework called Epiphany (designed by Natalie) which is shared by a cluster of schools across the area. This breaks down curriculum content by year group, and provides teachers with information on the types of resources to use and where they can find them, as well as progression and cross-curricula learning opportunities. Greg has plans to develop and expand on this framework for computing, which will also help teachers to identify areas where they feel less confident.

Another challenge for teachers at Bengeworth has been getting to grips with computing language and terminology, such as 'algorithms' and 'debugging'. Understanding the terminology has been an important step, and Natalie found that downloadable guidance for primary teachers, written by members of NAACE (the Education Technology Association) and published by Computing At School (CAS), to be a particularly clear and helpful starting point. As a member of CAS Barefoot, Greg was sent a pack for the school, including a poster on computational vocabulary and real life applications, which helps other teachers to feel more confident.

Resourcing to deliver the computing curriculum

Establishing sufficient resources to deliver the new computing curriculum (hardware, software and teaching materials) has been another important step. This has been propelled by David's vision and his strong advocacy of technology-enhanced learning. After evaluating staff and resources, David developed a strategy that the school could afford. The aim is for all Year 4 and Year 5 pupils to have their own iPad in 2-3 years, which they can use for homework and in school. In partnership with parents they buy the device over a two-year period.

The school currently has 16 DELL computers and four iMACs, and is working towards developing a computing suite with up to 30 iMACs in the near future. The school orders other bespoke equipment from a local firm, Goldfinch Technology Limited, whose staff also assist with teacher training to help the school get the most of those resources.

"When we are confident and have our new IT suites, we will allow other schools to come in to use our resources and we will aim to upskill parents and run courses such as Microsoft exams."

David Coaché, Head teacher

Many of Bengeworth's teaching materials for computing are acquired at little or no additional cost, and much is done using Microsoft or Google software.

Teachers save documents to the cloud, so they can be worked on and updated anytime and from school or home.

Supporting the teaching staff is Stefan Delorenzo, Education Manager at D&D Network Services Limited, a specialist local IT consultancy. Stefan teaches aspects of computational thinking and associated vocabulary to pupils, such as the steps needed to program a robot to make a jam sandwich, and debugging problems in that process. As Natalie pointed out, Stefan *"really helps to enthuse the students and it's valuable to have him on board for staff training."*

Approaches to coding

Pupils at Bengeworth begin to learn coding using the Scratch Junior and Espresso programming languages, which helps them to develop independence in computing. The choice of language is differentiated by year group, and higher up the school, they move on to more advanced languages such as HTML and Python. To put their coding into action, pupils in Key Stage 1 learn to programme bee-bots (small bee-shaped robots) to perform particular actions. They then go on to the more advanced pro-bots (race-car-style robots with sound and light sensors).

Natalie describes how they have related coding to the topic of Dick King Smith's book, *The Hodgehog*, in which a hedgehog needs to learn how to cross a busy road to reach the park. Using a traffic-light coding programme, pupils learned how to programme a car to respond to red, amber and green, with some pupils going further to explore the sequence of the traffic lights.

Stefan Delorenzo runs an after-school computing club at Bengeworth in which pupils learn and practice Pyonkee, a Scratch-based iPad app, as well as Tynker, a complete learning system that teaches children how to code. This includes experimenting with visual blocks and text-based coding which can help in designing games and other projects.

Embedding computing into class themes and topics

With more confident and knowledgeable teachers, as well as the physical and teaching resources in place, Bengeworth has identified how computing can underpin learning across other subject areas.

Every half term, pupils learn in the context of a major theme, and computing offers opportunities to bring that to life. Year 2 teacher Natalie Snowdon covers

the topic of Seaside Rescue and the children use the Comic Life program to create digital comics using adapted digital photos and text boxes. Greg's Year 4 group have been learning about Ancient Egyptians. This covers Tomb Raiders and children learn about debugging 'bugs in the system'. Another theme is Habitats where pupils create a virtual game to explore local environments.

"Technology can help some pupils to access learning they might otherwise find difficult and become more digitally literate. Last year we had a pupil who struggled to write a news report, but using the iPad, and through the use of video, they were able to express this in a different way."

Greg Satterley, Year 4 teacher

Anya is in Year 5 says that her teachers are encouraging and that computing helps you to learn without even realising that you're working. Thomas (Year 3) is already thinking about becoming an electronic games producer.

Bengeworth's tips for success

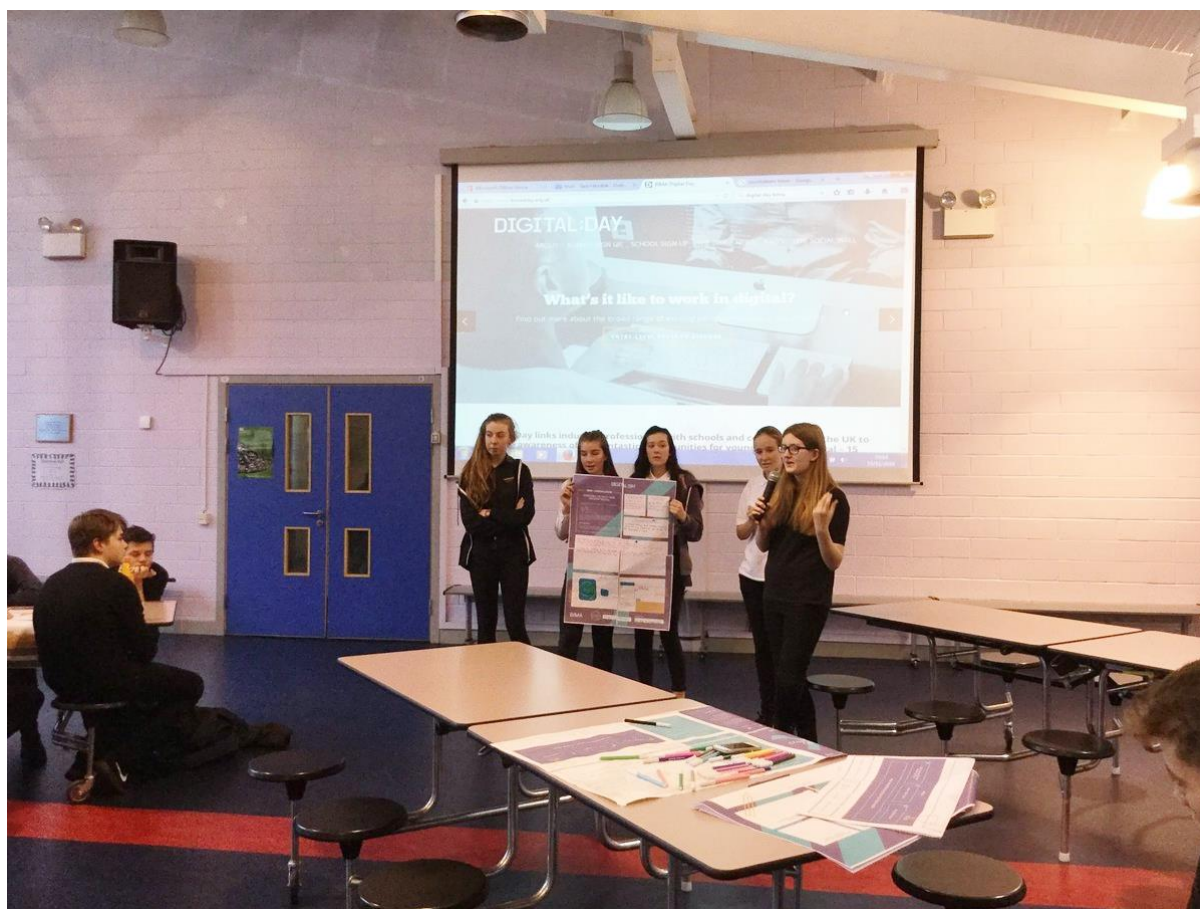
- ✓ Give computing a go but take it one step at a time and don't try and do too much too soon. If something doesn't work, try something else.
- ✓ Staff need to feel confident about computing, even if they don't have all the knowledge. CPD and a mutually supportive working environment are really important, including sharing ideas and good practice across the school. Resources available through being a member of CAS can be a helpful starting point.
- ✓ Identify other organisations and specialists who could support with delivery of the curriculum and talk to the Head teacher about this if extra money is needed. Some commercial resource providers offer linked training, and there may be local technology-based firms who are looking for educational/outreach opportunities.

Case Study 3. Craigmount High



Craigmount High School, West Edinburgh, aims to provide its young people with the administrative, entrepreneurial and computing skills essential for the 21st century.

Computing education at Craigmount



To make the most of complementary learning opportunities, Craigmount High teaches Business Education and Computing through a single faculty. This is headed up by Sara Hendrie, Curriculum Leader, alongside two dedicated Computing teachers and three Business Education teachers. The school has experienced a shortage of available computing teachers to fill vacancies, therefore the faculty has been supported by two maths teachers, who are registered with the General Teaching Council in Scotland, to teach Computing,

Since August 2014, students in S1 (equivalent to Year 7 in England and Wales) have been undertaking one period per week of Digital Literacy and one period of Business Education. At S2, Digital Literacy is replaced by Computing Science. At S3, students can continue in the faculty by choosing from Computing Science, Computer Games Development, Administration & IT or Business Management

At S2, and to help inform students' S3 subject choices, the school runs a programme called *Progressive Minds*. For two periods per week, students can choose from a number of specialist courses to broaden their interests. The

optional courses offered by the faculty include Games Development, Apps for Good, Enterprise and the School Website. One option is iMedia, which spans video media, production and technical knowledge – including a visit to Sky Studios in Livingston. Other options include film philosophy, Spanish and clay modelling to name but a few.

The computing journey

For Sara and her team, delivering computing education is a continuous journey. Key to maintaining momentum has been buy-in from the senior leadership team to the importance of digital literacy and computing skills to the local economy. To help with the journey, Craigmount has built relationships with computing firms and nearby Edinburgh Napier University, for example students go on visits and industry representatives visit the school to give talks and work with the students.

The staff follow the philosophy of being 'reflective practitioners', which helps in terms of sharing ideas and reviewing/adjusting teaching approaches and learning content. Computing teachers recognise the need to keep on top of Career Long Professional Learning (CLPL) and acknowledge that the subject, particularly programming languages and syntax, evolves at a fast pace.

Attracting and recruiting computing staff has been a significant obstacle, which Sara puts down to not enough people in the industry available to teach the subject.

"There is still a general misconception around what computer science is really about, but this is gradually starting to change. We're promoting coding and problem solving in the school and that's starting to generate a lot more interest among students and parents."

Sara Hendrie, Computing Curriculum Leader

Making a complex subject fun and engaging to learn

Sara acknowledges that computing can be perceived by some students and parents as comparatively difficult subject, especially due to the amount of theory involved during the Senior Phase (beyond level S3). The staff recognise that some students might be put off from pursuing computing if they don't feel confident it will give them the best results. Furthermore, when a small sample of students were asked how difficult they find the subject, most describe it as "moderate" as there are "a lot of facts to remember for the exam".

To engage and excite students in the subject, the school offers a rich array of activities and competitions throughout the school year. Some of these have been developed by the school, while others draw on national and even global initiatives which schools can sign up to.

- A small number of S1 students are encouraged to become 'digital leaders' at Craigmount, by sharing knowledge about using technology (including safety/security aspects) during assemblies and at parents' evenings.
- At S2, students get involved in a competition called *Invent A Device*, for which they come up with an idea for an invention (such as a piece of wearable technology), undertake design work, prototyping and then vote for a class winner. The winners then go forward to a 'Dragons' Den' style presentation to industry representatives who are invited in to the school.
- S3 students participate in an annual *Digital Day* – a national industry sponsored initiative which links up business professionals and schools to give students an insight into the world of digital careers. The afternoon is dedicated to a competition where students tackle a design challenge, for example 'improving people's lives through digital'. This puts them in with the chance of being crowned Digital Day champions.

Going forward, Craigmount would like to encourage more students to take computing at S3, particularly girls. To help with this, the school takes part in the UK-wide extra-curricular club, *Tech Future Girls*, in which students take part in activities such as making up their own dancing algorithm and then creating an animation of the dance using the Scratch programming language.

Working with feeder primary schools

An obstacle which many secondary schools may face, is students entering the first year with varying levels of knowledge and understanding about computing. Ideally Sara would like to spend more time working with feeder primary schools who aren't all equally engaged with computing, and examples of some of

Craigmount's activities have included:

- *Hour of Code* – an annual and global campaign run by Code.Org which consists of one-hour tutorials. For this event in December, Craigmount invites primary school pupils at level P6 and P7, along with computer

industry representatives, to visit the school. Pupils have a go at coding animated shapes and characters using programs such as Minecraft.

- *Safer Internet Day* – an annual event in February run by Childnet, whereby some of Craigmount’s students visit local primary schools to promote the safe and positive use of digital technology.

The student experience

During an S2 class observation, students looked at scripts written in Scratch and were asked to find an error that was causing the program to behave in an unexpected way. They were then asked to code an animated bunny to jump up and down, talk and wag its tail, followed by another character that would jump after the bunny jumps.

The enthusiasm for computing among Craigmount’s students is self-evident. Connor in S4 likes learning a new language, then creating a program to “visualise” that learning. Lee in S5 enjoys understanding how languages are turned into code to operate machines, while Lydia (also S5) finds it interesting to pin down solutions to problems, as well as creating websites in HTML.

Students are able to identify how computing is relevant to the world of work, for example while ‘databases’ is considered by some students to be the most difficult topic, Lee in S5 believes this is a good and important skill for the workplace.

"I want to do something with computers for definite and I'm leaning towards games design... I feel like having superior knowledge in computing will help me."

Connor, S4

"Programming is a great skill to have... I'd like to be a mechanical engineer."

Ross, S5

Craigmount’s tips for success

- ✓ There are a great many opportunities and resources that teachers can tap into to support computing education, including global and national initiatives that can help to pair up schools with industry;

- ✓ Sharing resources and ideas between schools helps to prevent "reinventing the wheel";
- ✓ Secondary schools could identify ways of more strongly engaging their feeder primary schools, for example through activities such as *Hour of Code* and Safer Internet Day.

Case Study 4. East Barnet School



Located in north London, East Barnet School is a secondary comprehensive with approximately 1,350 students aged from 11 to 19. Its motto, '*I want to learn*', reflects the school's ethos that motivation is the most important factor for achieving success in education.



Responding to the curriculum challenge

For Head teacher Nick Christou, the new computing curriculum taps into the importance of offering students a broad education, using creative approaches to spark their interest and enthusiasm, and helping young people to make genuinely informed choices about what to do next.

Computing has been introduced slowly and cautiously at East Barnet over the past two years and this has not been without its challenges. There has been a need to develop engaging content, nurture staff confidence and knowledge, and broaden the appeal of the subject, especially among girls.

Much of the work to date has been led by Janet Christou (Head of Computing) and Hayley Bullen (computing teacher with curriculum oversight). The school also has two other computing teachers, John Warr and Rob Fitzgerald, who with the support of colleagues and their own investment in professional development, made the transition to computing from the more traditional world of ICT.

"We're a very mutually supportive team and it's great to share ideas, challenge one another and build confidence. Rob hadn't used [the coding language] Python before and so he needed to get to grips with that. We also have faculty meetings to discuss what's working well and what we think should change."

Janet Christou – Head of Computing

Computing at East Barnet

At Key Stage 3 (ages 11 to 14), East Barnet teaches five main study themes: Computers, Programming, Algorithms, Database Design, and Communication and the Internet. Interactive lessons have been designed to empower students with knowledge and trust in technologies that are prevalent in the society of today and the future.

At GCSE, students learn more about computing concepts, aspects of software development, and the fundamentals of programming, computer networks and cyber security. Alongside the GCSE, and to appeal to students with a creative flair, East Barnet offers a Certificate in Digital Applications (CiDA). This teaches these students how to design and make effective digital products for others to use, such as websites and interactive multimedia.

Students that gain a grade B in Mathematics GCSE, and at least a grade B in GCSE Computer Science, can go on to the A level where they learn more about the theory of logical reasoning, algorithmic thinking, design and problem solving.

Since the curriculum has become embedded lower down the school, East Barnet has already started to see more girls choosing to take the GCSE or CiDA qualification, with the next step being to inspire more girls to consider the Computer Science A Level.

A variety of coding languages are taught at East Barnet, starting with Scratch and Alice in the younger years, before working towards more complex and challenging textual language from Year 9, such as Python.

Creative learning approaches

Computing at East Barnet is delivered through a variety of creative approaches, from developing games to programming Lego EV3 robots to navigate an obstacle course, and from team competitions to industry visits. Learning involves trial and error, shaping the mind how to think logically, problem solving, as well as being

relevant to the modern world. As Nick Christou puts it, *"without those skills, how can students expect to be able to compete in the modern world?"*

Some aspects that the students find challenging can often lead to a fuller feeling of success later on, for example Sarah in Year 9 explains the frustration of experiencing syntax and logic errors, but describes how *"it's great when the thing you're programming finally works"*.

"Computing changes the way you think. When a problem looked complicated, I used to step away. But now I've learned how to break problems into smaller parts and that's helped me in my other subjects."

Ruth – Year 10

Extra-curricular activities include a lunchtime robotics club that's run by A level students and attended by younger pupils. The club creates enthusiasm and a sense of healthy competition and builds up towards competitions with other schools. Additionally, the school has built links with The Guardian newspaper, so Year 9 students have the opportunity to visit their offices and practise HTML coding.

Andy and Callum, both in Year 12, make apps outside of school and describe how what they've learned in the A Level has helped them to make those apps more efficient. Both of these students aspire to be software engineers in the future.

"I enjoyed making a webpage advert for how to win house points at school. I also really enjoyed the animation work and I'd like to go into movie animation one day."

Andy, Year 12

A dynamic learning environment

One of East Barnet's key curriculum innovations to spark students' enthusiasm about the subject has been the 'Triple E School', which stands for Enhancement, Enrichment and Extension. On one afternoon each week, Year 7 and 8 students undertake two strands of activities that are purely focused on learning through inspiration. The computing strand includes activities such as robotics, film editing and animation, with the content used as a 'test bed' before being rolled out to support the main curriculum.

Another major development is the school's proposed migration to Skooler, a dynamic cloud-based file-sharing system. This will help to create effective 'online classrooms' so that students can submit work electronically and access suites of learning materials and resources that are attached to each lesson. This is especially helpful for computing lessons which draw on a range of visual aids and electronic media.

Smart use of resources

Hayley explains how the availability of external teaching resources for computing has grown tremendously over the past three years, so the trick now is to be selective about what to use.

Staff at East Barnet tap into external resources such as Computing At School (CAS) forums, PG Online, and ZigZag, as well as developing many of their own materials. This helps to make the best use of available resources, for example the school has made great use of BBC Micro:bits which consist of programmable sensors and LEDs. Hayley says "*we thought, let's have fun with these, so we came up with ideas such as programming them to play rock/paper/scissors*".

East Barnet's tips for success

- ✓ For schools that don't have teachers with a background in computing, it would be helpful to develop local links and pair up with one that does. Regular meetings and dialogue can help to share knowledge, resources and good practice.
- ✓ Talk to the head teacher about the benefits that computing brings to students and how it can support other subjects. Ultimately this can help if looking for more funding for equipment and resources and/or time for staff CPD.
- ✓ Be open-minded to learning with, and from, the students themselves. As Janet explained – "*the teacher has a slightly different role when it comes to computing, but the students are like sponges and their enthusiasm stimulates the whole class, including the teachers*".
- ✓ There are lots of resources available online to help teachers, and these don't have to cost a lot of money. Other schools could try these out and develop their own lesson ideas to make learning fun and interesting.

Case Study 5. Inverbrothock Primary School



Located in Angus, Scotland, Inverbrothock Primary provides a positive and motivating ethos in which all children are encouraged to achieve their potential. Learning about technologies is considered vital, helping pupils to be informed, skilled, thoughtful, adaptable and enterprising citizens.



Responding to a changing local economy

Manufacturing and oil production have traditionally been important to the local economy in Angus. The effects of the recession in the late 2000s, coupled with a rapid fall in oil prices and high oil production costs, have led to significant reductions in activity in recent years². The professional, scientific and technical sector now accounts for the highest share of registered businesses in the Angus area, while less than 20 miles away in Dundee, job losses in construction and manufacturing have given way to new job creation in science and technology-based firms³.

The changing local economic profile is just one reason why Inverbrothock Primary School has embarked on a journey to deliver a strong foundation in computing education to its roll of over 300 pupils. As Head teacher Jennifer Morison points out – *"it's a different world now, and we need to think about the skills our young people are going to need for the future."*

² SQQ (2016) *State of the Angus Economy – Final report to Angus Council*

³ Dundee City Council (2016) *Dundee City Economic Profile*

Embarking on the computing journey

Jennifer initially became intrigued about computing education after seeing a lot of Twitter activity on the topic. This led to a conversation about coding with Principal Teacher, Joy Christie, who spoke to a former colleague who was on secondment in Education Scotland to find out more. Joy since attended a Career Long Professional Learning (CLPL) session that was coordinated by Education Scotland and Angus Council. This focused on aspects of computing science, as well as support for using resources such as Barefoot, the Scratch programming language, and the Computing Science hub on GLOW⁴.

Neither Jennifer nor Joy have a background in computing, but both became inspired to take it further. A willingness to put some of their own time into CLPL activities has helped with the spread of skills to colleagues, and staff have since become enthused by digital technologies and computing education.

Both Jennifer and P5 teacher Many Dryden mention how changes to Scotland's *Curriculum for Excellence – Technologies* makes it easier than before for schools to identify what's needed in order to achieve the relevant benchmarks. They also find it helpful that the new outcomes more clearly distinguish between computer science and digital literacy.

"We want to embed computer science right across the school, use technologies in new ways, and ensure all our children have the opportunity to develop and apply computational thinking skills."

Joy Christie, Principal Teacher

Thinking outside the box

The school has hit the ground running by making the best use of available resources. It has put in place a lunchtime code club for P5 pupils (equivalent to Year 5 in England and Wales), taken part in the annual *Hour of Code* initiative (run by Code.Org), and used *Barefoot* resources to run a combined P3 and P4 project to develop computational thinking skills. In addition, the school has set up its own video channel on GLOW and participated in the 'Mannequin Challenge', which helped to identify teachers with video talents.

⁴ GLOW is a cloud-based application library and digital learning environment for Scotland. It contains learning resources that teachers and pupils can access from anywhere.

Staff have experimented with different ways of teaching computing, using technology such as programmable Bee-bot robots, as well as 'unplugged' activities, which help children to develop logical thought processes without having to rely on hardware. As an example, children are tasked to look around the school for examples of instructions that resemble algorithms, such as the steps to correctly operate a fire extinguisher.

Teachers have also identified interesting ways of making computing and computational thinking relevant to learning in other subjects. This has ranged from decomposition of poems, to programming a bee-bot to navigate its ways between local landmarks depicted on a floor mat.

"We came up with a dance routine to help children learn about algorithms by following and acting out instructions in the right order. This has really helped to make learning fun."

Mandy Dryden, P5 Teacher

To get the most out of every student, Mandy describes how they pair up more able and less able pupils. The teacher will then provide more support in class for those who really need it, whilst others can take a more independent approach.

Working with available resources

Delivering computing education at Inverbrothock has not been without its challenges, which other schools may well identify with. Limited bandwidth has made it difficult to access certain GLOW materials, update iPads and install apps. The school doesn't currently have enough hardware to go around (e.g. netbooks and laptops), has a lack of charging sockets, and the age of some of the equipment means that some batteries are no longer in good working order.

To date, the school has worked around through careful timetabling of equipment use, and making great use of unplugged activities as mentioned above.

Nurturing local links

Maintaining an active interest and involvement with other local schools, colleges and organisations helps to create new learning opportunities for computing. Inverbrothock regularly meets and plans with Arbroath High School and has established good links with the Victoria and Albert Museum, which runs a number of outreach activities and embraces digital technologies through learning.

Spreading the enthusiasm

Staff at Inverbrothock are not afraid to learn computing along with the pupils, and Mandy Dryden (P5 teacher) makes the point that other teachers shouldn't be put off by thinking about what the subject may have been like in the past.

Katie Motion teaches P1 pupils and has been in the profession for five years. Although she doesn't have a background in computing, she followed Joy's lead in taking advantage of local CLPL training where she's had the opportunity to meet and share ideas with other practitioners and gain insights into the range of computing-related teaching resources.

"I initially dipped my toe in the water with blue bots and have since set up the Code Club with the P5 pupils which helps them to take their learning in different directions."

Katie Motion, P1 Teacher

The children themselves really enjoy learning computing and were happy to give up their break time to talk about their experiences. Among the P4 pupils, Zara describes how computing helps the class work together as team, which also helps with friendships. Scott likes how computing can be used for maths and spelling games, while Dylan found it interesting when working with younger P3 pupils, to make an animated rocket.

Hannah is a P5 student and feels that computing has helped to develop her problem solving skills in maths, which was echoed by Zara who says that computing *"helps to get your brain working"*. Katie (P5) believes that it's important not to give up when you sometimes get the coding wrong, and Aulay (also P5) is already thinking about how he'd like to be an animation artist in the future.

"At first computing wasn't for me. It's in a different language. But then I got better at it and realised how it can help you to be creative... One day I'd like to be an illustrator."

Hannah, P5 student

Inverbrothock's tips for success

- ✓ Try not to be put off by the perceived skills and experiences of other practitioners, and embrace learning along with the children.

- ✓ Whilst the use of technology is an important aspect of computing, unplugged ideas (i.e. without needing to use a computer) are also useful and effective for practising computational thinking skills;
- ✓ Encouraging collaborative working between pupils is also really valuable, for example getting the older ones to support young ones, and more able pupils to support less able.
- ✓ Partnering with other local schools, colleges and organisations can be a great way to tap into other resources, knowledge and sponsored activities in the community.
- ✓ For schools in Scotland, make links with Education Scotland and the local authority, to find out about professional development events that may be taking place.

Case Study 6. Kings Priory School



Kings Priory in Tynemouth is an all-through Academy that was formed in 2013 as part of Woodard Academy Trust. The Academy caters for over 1,300 pupils from age 4 to 19 and strives to develop skills in leadership, teamwork and problem solving, alongside a sense of self-worth, positive attitude and a high degree of self-discipline.

Computing at Kings Priory



Principal Philip Sanderson places importance on Kings Priory being able to respond to the pace of technological change. This means teachers being able to learn from the pupils in order to develop relevant, challenging and stimulating learning. The Academy makes the most of cross-curricula opportunities, from using Sibelius software in music, to Computer Aided Design (CAD) in technology classes.

"Computing is very well established in the school. Every subject has some use of ICT or computing and the pupils will often use software that is bespoke to that particular curriculum area."

Philip Sanderson, Principal

Computing is taught from primary through to A Level. Jeanette Patterson is the Curriculum Team Leader for the Computing and Technical Applications Faculty, and aspires for all pupils at the end of Year 9 to have the computational thinking skills necessary to undertake the GCSE in Computer Science, even if they choose not to do so.

"Because we have been teaching computing for a few years, we are beginning to teach certain aspects at a younger age. Some of the content that we previously taught in Year 8 are now taught in Year 6."

Jeanette Patterson – Curriculum Team Leader Computing

At Key Stage 3, pupils learn about logic, algorithms, data representation and coding, using the programming languages Robomind, Scratch and Python. At GCSE, their knowledge extends to include computer systems and the ethical and legal concerns around them. At A Level there is an even stronger focus on programming and using high level programming languages.

At Key Stages 1, 2 and 3, the progression pathways from CAS are used as a basis for the curriculum. Jeanette mentioned that this provides a great deal of flexibility in terms of the content that can be covered, particularly compared with the GCSE and A levels.

Creating and sharing computing resources

Computing teachers Jeanette, Laura and Nik create the majority of teaching resources themselves, which are tailored to the abilities of students. Some online resources have been found to be better than others, so these are sometimes adapted.

Teachers use worksheets to explain tasks, which help pupils to focus and understand the theory of what they are learning. A progress tracker document and evidence log also helps them to take responsibility for their own learning and progress.

Pupils have their own Google Docs accounts and teaching resources are available for them to access at any time. Other online tools available to students include flipped learning websites such as Ted Ed, which points pupils to further reading, informative videos and relevant lesson preparation materials; as well as Blendspace, which provides even greater shared access to teaching resources.

Creative learning approaches

Computing is becoming increasingly popular at Kings Priory with the numbers taking the subject at GCSE and A Level increasing year-on-year. This is partly put down to the lessons being as fun as possible. Classes involve interactive activities and simulated kinaesthetic learning, which encourages pupils' creativity and problem solving skills.

Students also undertake a range of ‘unplugged’ activities to help them practise the types of skills and precision needed for coding purposes, for example, when working in pairs, one student will control the other like a robot and direct them across the room.

Lessons are assessed through verbal feedback to pupils and the progress tracker worksheets help them to see how their results change as they progress.

“We get a progress sheet from the teacher every lesson and they give us feedback. In each lesson we write on there what we’ve done after we get the feedback.”

Olivia, Year 8

As part of the case study visit, students were observed designing a mobile app. The lesson was structured to begin by talking through the activity as a class, then making a plan individually and with support from one another. The second half of the lesson involved students working individually on computers to develop their mobile app.

Broadening the appeal of computing

As well as fun, interactive lessons, girls are encouraged to take up the subject through events such as North East Digital Girls, and Laura runs a lunchtime session for Year 5 and 6 pupils called Tech Future Girls. This is proving popular and is always fully subscribed.

“A good teacher should be able to cater for all. It might be through additional support to less able students, or supplementary tasks being set for more able students. It’s challenging for a teacher but we achieve that through careful planning.”

Jeanette Patterson – Curriculum Team Leader

The enthusiasm of pupils is self-evident at Kings Priory. Many concepts taught early on provide the skills to help them problem solve and think logically in other subjects. In English for example, computing can help students to think logically about how to compose and structure a letter.

“I did want to be a PE teacher but now I want to work in the Apple store. They fix computers and fix viruses and other devices. I can learn all this through computing.”

May, Year 8

The A Level students learn about data structures to help them make decisions about appropriate tools for given problems. They also learn about graph theory in the context of mobile phone masts and have used binary trees which help them with a range of problems including those found in maths. The lessons include a mixture of theory and practical work, and the students feel the balance is just right.

"The classes have a good range of practical and theory but the theory is really diverse and not tedious. There are lots of ways we can apply it."

Josh, Year 12

Tips for success

- ✓ Buy in and support from senior leadership teams (financial and non-financial) is extremely important, especially with time likely to be a barrier for some schools in terms of developing learning content or resourcing the subject with sufficiently knowledgeable and specialist staff.
- ✓ Ensuring a mix of theory and practical activities can help to make learning fun. Meaningful teacher feedback, during and at the end of each lesson can also help to give students a better insight into how they are doing and maintain their focus.
- ✓ Don't be afraid to mix and match teaching materials, to better tailor these to the needs and abilities of students.
- ✓ Focus on computational thinking skills, as this equips learners to solve problems through cross curricular activities and not just in computing/computer science lessons.
- ✓ Computing lessons which have embraced computer science, ICT and digital literacy at Key Stage 2 and Key Stage 3 has helped to strengthen uptake by girls for GCSE Computer Science and removed the barriers.
- ✓ There are lots of free resources and programming IDEs⁵ available to schools that students can access from home, such as Scratch, Python and Visual Basic.

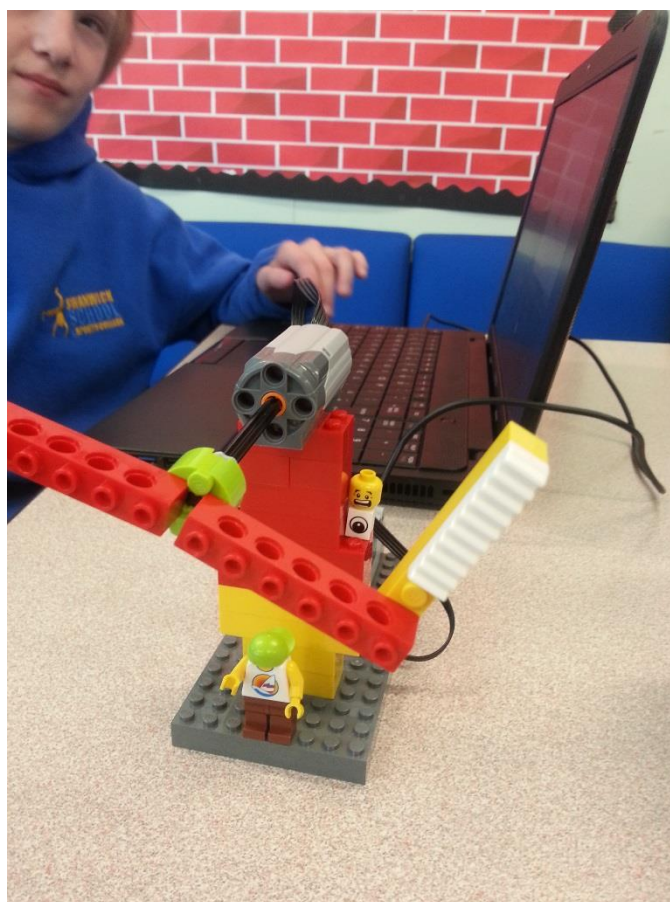
⁵ An integrated development environment (IDE) is a software application that provides comprehensive facilities to computer programmers for software development.

Case Study 7. Swanwick School and Sports College



Based in Derbyshire, Swanwick School and Sports College caters for children with a wide range of social and educational needs. Its students (around 80 in total, aged 5-16 years old) are encouraged to "*enjoy, achieve and exceed their individual potential - academically, socially and personally*", and to become active members of society.

Computing for students with a range of needs



Students at Swanwick School and Sports College (SSSC) have learning, behavioural and emotional needs that may be considered moderate to severe. Head teacher Chris Greenhough describes how computing motivates some students to attend school, and that coding and robotics "*encourages patience, control and focus, as well as improving students' concentration skills.*"

Primary age pupils focus on learning ICT, which is embedded across the curriculum, and provides a functional grounding in the subject. Computing is then taught from Key Stage 3 and covers the three distinct areas of Computer Science, ICT and Digital Literacy. At Key Stage 4, the school offers an Entry Level Computing qualification and Awards in Using Raspberry Pi Computers and Scratch Programming. These awards give credits towards college courses.

Effective teaching approaches

Just a few years ago, digital literacy wasn't taught at all at SSSC. In response to the new curriculum, computing was introduced by teacher Matthew Parry.

Matthew has an industry background in computer programming, is a Computing At School (CAS) Master Teacher, and volunteers for Barefoot, a project which aims to support primary school teachers with the computing curriculum.

To make the most of Matthew's expertise, other members of staff at the school focus on teaching aspects of ICT, to free up Matthew's time to deliver the core elements of computer science. Matthew secured a £5,000 grant from the British Computer Society which funded the purchase of PICO boards (interface for the Scratch programming language) and Lego Mindstorms kits. Other resources have been obtained from CAS.

A tailored curriculum to inspire students

Computing lessons at SSSC mainly involve practical activities. Class sizes are kept small (usually no more than eight students) so that each individual gets the support they need from the teacher. In their lessons, students work with robotics, undertake computer-based design, gaming and programming. To help them to understand algorithms, they carry out a number of 'unplugged' sessions to act out instructions before they embark on computer-based coding.

Matthew emphasises the importance of teachers persevering and encouraging students to take things step by step. This helps those students who struggle to engage because they want to see results straightaway (which this isn't always possible in a subject that required trial and error). Matthew has also found effective ways of engaging students with Asperger's Syndrome, who often give 100 per cent to a task when it's something they're really interested in. Some of these students have really taken to Minecraft, which enables them to create their own environment. As Matthew says, *"while they'll struggle to write, they'll happily build and code"*.

"One student hadn't been to school for years and he showed an interest in using the Raspberry Pis. He now goes into English and maths groups and is accessing so much more through his interest in computing."

Matthew Parry – Head of Computing

Developing students' aspirations through computing

The school's approach to teaching computing is popular among the students, with Child A in Year 8 describing his computing teachers as *"probably one of the best in the school"*. This is echoed by Child B, Year 10 and Child C, Year 11, for whom the practical activities really help to make school work fun. As an

example, Child B explains how he programmed and built a robot to follow a black line, then when the black line disappeared, the robot was programmed to search for the line again before it continued on its track.

"You get to show off a cool programme instead of writing – I like that it's so practical."

Child B, Year 10

There are some aspects of computing that the students find less enjoyable or more difficult than others, for example Child D in Year 7 says that he would prefer to have his own laptop rather than sharing as he is *"not very good at working in teams."* He also feels that the golden rule of the internet is *"being careful where you click!"*

While Child C is unsure whether she'll use computing after she leaves school, Child E, Year 11, and Child F, Year 9, both aspire to be games designers. Child A in Year 8 wants to design rollercoasters and Child D would like to make videos for YouTube.

Ensuring a sustainable future for computing education

Being a small special school means that every subject tends to rely on the specialist expertise of an individual teacher.

In January 2017, Matthew Parry temporarily left SSSC on a six-month secondment, and while the school will effectively be 'treading water' until he returns, Chris Greenhough mentions the importance of maintaining a long term vision and momentum for computing so the subject is sustainable and not reliant on one staff member alone.

Swanwick's tips for success

- ✓ The CAS Master Teachers are there to be utilised. Contact them, work with them and learn from them.
- ✓ There are many useful teaching and learning resources online. Schools could try these to develop their own lesson plans and activities, tailored to the abilities of their students.
- ✓ Don't panic if students don't engage right away. Like any subject, some will love it and some won't, but allow them to experiment and learn from mistakes.

Case Study 8. Western Primary School

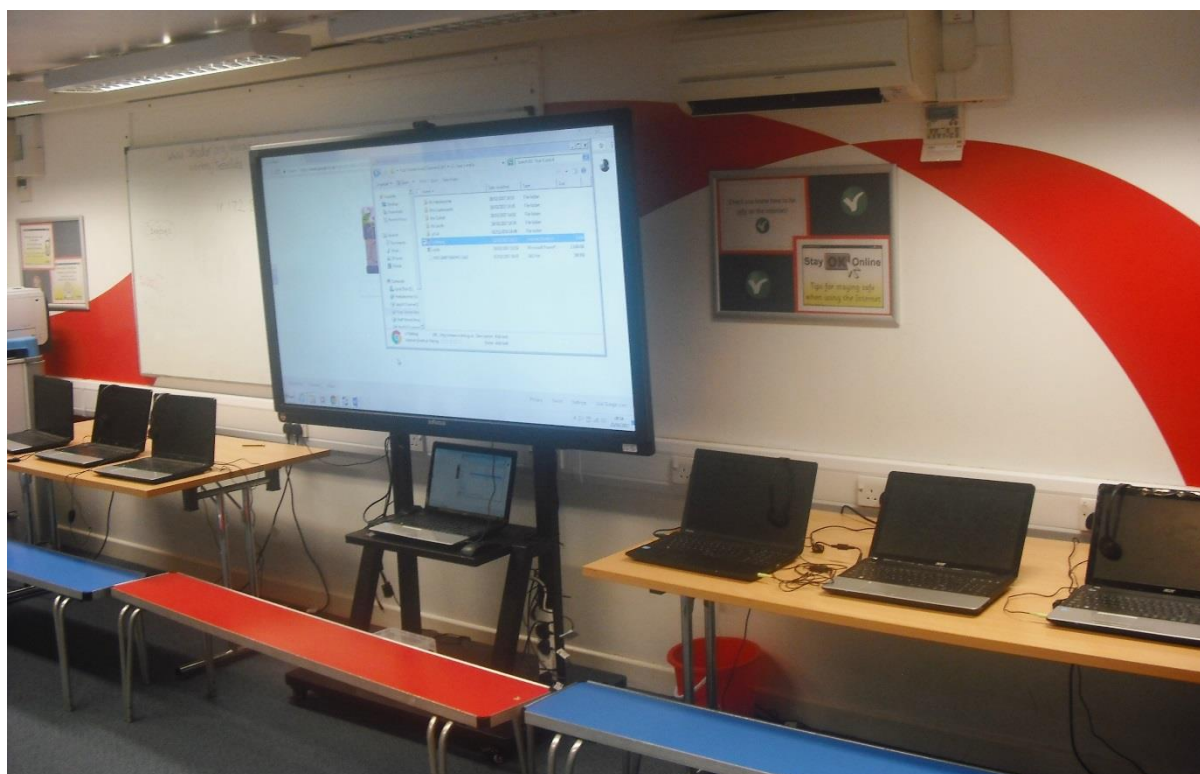
Western Primary School

CREATING SUCCESS STORIES



Located in Harrogate, North Yorkshire, Western Primary School is an academy with approximately 485 pupils aged from 3 to 11. Its motto, '*creating success stories*', reflects the school's ethos and aim, to develop in their children a love of learning that will last a lifetime.

Computing at Western



The ethos of computing education at Western is about offering a broad curriculum and using varied resources which are highly stimulating for pupils.

Year 3/4 teacher and computing co-ordinator Richard Hebblewhite has helped to put in place a wealth of resources including iPads, CodeBugs, Bee bots and Lego for coding. Pupils in Years 5/6 learn how to design, write and debug programs, as well as how to develop apps and interactive games.

Teachers Richard Hebblewhite and Suzanne Brooke work closely together to ensure pupils in Years 5/6 are taught new aspects of computing, building upon, rather than repeating knowledge gained in Years 3/4. Richard and Suzanne remain conscious that pupils are exposed to computing from a very early age, for example via iPads at home. For that reason they ensure the curriculum is regularly evaluated and refreshed to keep the content fresh and up-to-date.

E-safety is also strongly embedded into lessons. Year 5/6 teacher Suzanne Brooke says that pupils are given email addresses and taught how to remain safe online, and to think about what kind of information they may be giving to people they don't know. The school also has an internet safety day.

Western's dedicated computing suite is where all computing lessons are taught and where all equipment is kept. After head teacher Cheryl Smith attended the annual BETT Show, the world's leading education technology event, the school made the decision to invest in iBoardTouch – highly innovative interactive touch screen technology. Richard Hebblewhite says that iBoardTouch screens are far more accurate than smart boards, and are also very effective for pupils with Special Educational Needs (SEN), as they can be raised and lowered. As Key Stage 1 Leader Sarah Jones explains, iBoardTouch screens are now in all classrooms and used in most lessons.

"We've seen a huge boost in Key Stage 1 when we're using the boards – the children are almost mesmerised by them"

Sarah Jones – Key Stage 1 Leader

Responding to the curriculum challenge

Suzanne Brooke explains that Western used *Rising Stars* as a starting point when transitioning to the new curriculum, as it offered them a wide range of resources including books, an assessment framework and science activities for iPads.

Initially there were plans to remove the dedicated computing suite and teach computing in classrooms. However staff quickly realised that this created a risk to equipment, which could be broken or lost as it was moved around school. Suzanne and Richard also recognise the value of maintaining core ICT skills within the curriculum such as use of Word and PowerPoint, alongside the new content of coding and the like.

Suzanne says that pupils with special educational needs (SEN) very much enjoy computing lessons, and Richard says that female pupils are also embracing the new curriculum.

"The new computing curriculum is brilliant. Teachers enjoy teaching it and pupils enjoy learning it"

Richard Hebblewhite, Year 3/4 teacher

Year 5/6 pupils observed in a lesson were extremely engaged, and Suzanne explains that they grasp the concepts very quickly. Pupils say they enjoy computing because *"it is all new – we've never done anything like this before"*.

Staff at Western now make good use of external resources such as *Rising Stars* and *Code Academy*, as well as developing many of their own materials.

Cross-curricular activities and informal learning

Western takes every opportunity to make cross-curricular links between computing and other subjects. iPads have been introduced into classrooms, allowing pupils to carry out research, for example in geography lessons pupils use Google Earth to look at maps and research different countries. In English and drama lessons, slow motion video is used.

Extra-curricular (informal) activities include computer explorers, Lego, and Minecraft clubs, which are very popular with pupils.

Formative assessment and regular evaluation

Formative assessment plays a key role in the computing curriculum at Western. Some work is saved to e-folders for teachers to assess. Staff plan to introduce Key Performance Indicators (KPIs) for computing to assess pupils' ability to undertake a range of tasks e.g. using code, on an on-going basis.

Technology Manager Peter Martin has evaluated resources and made changes to the educational apps in which the school invests. This ensures only the most useful are retained and has freed up budget to invest elsewhere. Peter also supports pupils in the classroom from time to time as needed.

Integral to the ethos of continuous evaluation and the pursuit of excellence, are Western's 'Success Groups'. The Technology Success Group meets at least once every half-term. One of the items on the agenda is equipment and consumable needs, in order to prioritise future investment. Crucially, the success group doesn't just involve teachers and support staff, but also has input from pupils from Year 2 and upwards. These pupils are given the opportunity to trial equipment and resources, and their feedback, obtained via mini focus group style discussions, is taken into account when changes and final decisions are made.

Peter Martin is currently investigating the potential for pooling resources between schools in the Multi-Academy Trust (MAT) which will give the school access to more expensive equipment. He is also considering investing in FizzBooks and iPad minis.

Professional development

Computing teachers at Western recognise the importance of investing time in their own professional development to build their knowledge and confidence.

Richard Hebblewhite made the transition into teaching from an industry background working in computing, so benefits from his own existing expertise. Suzanne Brooke has invested a lot of time in her own development and knowledge. Both acknowledge that head teacher Cheryl Smith supports them to undertake CPD as and when required, to maintain and build their computing expertise.

"CPD training is vital. First and foremost it's about boosting the confidence and ability of the computing teachers."

Suzanne Brooke – Year 5/6 Teacher

Western's tips for success

- ✓ Talk to other schools that have embedded the new computing curriculum, find out how they have gone about it;
- ✓ Make CPD available to ensure teachers have the confidence to teach the content;
- ✓ Use Rising Stars or a similar resource as a starting point;
- ✓ Look for opportunities to share resources with other schools, particularly if part of a Multi-Academy Trust (MAT);
- ✓ Have regular discussions between computing teachers to consider how to update curriculum content and keep it fresh and engaging for pupils.