Developing 10 hours of practical computing curriculum at Key Stage 2: Invitation to submit fee proposal

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Computing, in its many forms, was a major contributor to economic growth, wealth creation and improved quality of life in the second half of the 20th Century; this will continue for the foreseeable future.

The global economy is therefore already dominated by pervasive Computing. While Computer Science is a rigorous, well-defined discipline in its own right, it also helps to play an underpinning role across many other disciplines, not just because software engineering is potentially helpful to these disciplines, but because computational thinking, with its emphasis on logical reasoning, algorithmic thinking, design and structured problem solving is increasingly drawn upon. Computational thinking, computer science and engineering have been at the heart of groundbreaking advances from the Human Genome project through climate change prediction to epidemiology. Massive engineering projects such as the Large Hadron Collider, the Airbus A380, and the Euro-fighter have all depended on successful software engineering – as have revolutionary consumer products such as the iPod. Computing is also central to the service industries, financial services, retail, hospitality, healthcare, and education.

But we are only just at the beginning of the digital revolution. Future wealth creation will be dominated by those who are able to engineer solid solutions in response to an exciting range of complex challenges including climate change, genetic engineering, smart grid, telemedicine, robotics, advanced manufacturing, nanotechnology and cyber-security. Cutting across all of these is the explosion of the mobile internet, which will not only reach every human on the planet, but will surround us with an expected 50 billion wireless-enabled embedded computing devices within a few years.

So far, we have highlighted the broad importance of encouraging rigorous engineering. However, it is also important to remember that every citizen will need to be able to use digital devices confidently, to understand their capabilities, to know how to act legally, how to avoid criminals and how to avoid accidental release of personal data. In a modern world dominated by software algorithms, it is undemocratic and disempowering that so many people simply do not understand how software works, and is built. We run a deep risk that we will create a massive divide between those who conceive and create the technology, and those on whom is it imposed.

What does this mean for the education of our young people?

For all of the reasons outlined above, we believe that every young person should have the opportunity to experience and learn real Computing, including Computer Science, from ages 5 to 19 in the same way that they experience mathematics or science. Computing is that important. We don't underestimate the scale of this challenge. We must attract and train many more teachers in order to make this happen, but the criticality of the next 10 years for Britain's economy means we have to start making a difference now.

The Computing experienced at school should be a sensible and affordable balance of appropriate formal curriculum, qualifications and extra-curricular activities such as after-school clubs. We recognise that teachers and schools will require ongoing support as the nation moves away from the current model of ICT in schools, and not all schools can move at the same speed. Over time more young people will need and choose to specialise in Computer Science and/or Information Technology, and appropriate pathways will be required for this including a range of GCSEs, A levels, vocational courses and university degrees. New technology, including creative use of online videos and podcasting, should be creatively used to ease demands on critical human resources.

We believe that more must be done to incentivise more schools to offer a challenging Computing experience for young people, and to make it clear to head teachers, teachers, parents and children themselves how exciting and rewarding software engineering can be.

The Role of the Academy

As well as playing a well-publicised role in the drafting of the new Programme of Study for ICT in the National Curriculum in England, the Academy is piloting an evaluated programme of Computing clubs in primary schools from September 2013. These will be delivered in partnership with existing club-related organisations, working towards a large scale, low-cost, sustainable primary sector Computing programme endorsed across the Computing and Engineering communities. We will be undertaking pre-pilot work throughout the 2012-13 academic year.

As engineers, we are naturally most focused on ensuring that Computing education in general, but especially Computer Science, results in rigorous software engineering (in conjunction with other engineering practice) - i.e. the design, construction, and testing of purposeful artefacts - not just abstract academic teaching. As part of this, the Academy has commissioned the design of a low-cost programmable robot. This is based round a programmable PICAXE microprocessor controlling a pair of stepper-motors mounted to a lightweight chassis. The robot can be programmed to move under its own power and is influenced by the signals from a wide range of sensors.

We intend this robot to be central to our pilot programme for Computing Clubs. It will be donated to schools involved in the pilot. However, we are also interested to explore how this robot could be used to exemplify the more practical aspects of the new ICT Programme of Study at Key Stages 1 and 2.

The services sought

We require a person with knowledge of the teaching and learning of science, technology, engineering and mathematics (STEM) in primary schools to develop **learning support materials** at Key Stage 2 to support the pilot and pre-pilot activities in 2013.

These materials should:

- Begin at a point where simple computing concepts have already been introduced to pupils at Key Stage 1.
- Be sufficient to cover 10 contact hours, steps of no more than 1 hour.
- Be suitable for use in an after-school STEM club or within the formal primary curriculum taking the published first draft of the ICT programme of Study as the reference point for the formal curriculum - http://www.raeng.org.uk/education/ict_programme_of_study/default.htm
- Be fun – 'hands-on and minds-on'
- Be creative and attractive (no need to desktop publish – we will do that later)
- Be educationally sound
- Be engaging for teachers with minimal knowledge of computing
- Be of practical value to teachers with minimal knowledge of computing – therefore they should be detailed, offering step-by-step guidance on the management of practical tasks as well as offering more general advice on pedagogical approaches.
- Explore the potential for wider curriculum links – perhaps to literacy, English, numeracy, mathematics or science

- **Build on** the following ideas (assuming these have already been introduced to pupils)
  - Seeing problems in computational terms
  - What is meant by the term *algorithm*
  - That algorithms are implemented as programs
  - That programs can be written to accomplish goals
  - Consideration of the wider impact – how are these skills used in the real world?

- Help **the ongoing development** of the following skills (assuming these have already been introduced to pupils)
  - The repeated practical experience of writing computer programs
  - Solving problems by decomposing them into smaller parts
  - Working collaboratively

The materials produced will be centred on the use of the programmable PICAXE robot referenced earlier. PICAXE knowledge is beneficial, but not essential, the focus is to produce learning support materials that are teacher friendly, educational and fun for the pupils. Advice and support will be given by the Academy and its network on the capabilities of the robot and basic programming capabilities.

The focus of the learning support materials should be:

- Building the robot (many items such as the circuit board are pre-assembled)
- Exploring the demonstration capabilities (example programs exist)
- Using the flowchart tooling (Logicator) to program the Robot
- Building simple flowchart based programs that explore key functionality:
  - What actions need to be taken when the robot bumps into something
  - How to follow a line
  - How to follow a light
  - Using a remote control to drive the robot
  - Utilising some of the additional features – sound, lights, communication devices

Although the focus is necessarily prescriptive, how these features are introduced is open to a variety of pedagogical approaches. Each activity should have some practical outcomes

defined with an optional extra fun element e.g. racing the robots, following an obstacle course, robot sumo wrestling etc.

Activities should make simple linkages with the wider usage of these concepts in the real world.

The emphasis should be on providing written materials. However, given the nature of the activities supporting video footage is an optional extra.

The skills listed above will require the use of a computing device. One of the Academy's programmable robots will be issued to the successful applicant. User documentation will be provided for the robot.

Submitting a fee proposal

To be considered for this work, interested parties must:

- Be able to deliver the required set of learning support materials by 1st February 2013
- Sign over copyright to the Academy who will make them available (once professionally laid out at the Academy's cost and subject to separate commission) free to download from websites under Creative Commons licensing

and

- Submit an outline of the approach they would adopt – 1000 words or less
- Submit a schedule (2 pages maximum) of how the 10 hours of contact time would be broken down into components / activities of no more than 1 hour each
- Submit a brief resume of relevant experience (1 page maximum)
- Submit a single fee proposal which should be inclusive of VAT (if applicable) and all expenses

By email to

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in order to arrive no later than 12 noon, Friday 30th November 2012. The successful applicant will be contacted within 10 days of that date.

The criteria used for selection of the successful applicant will be:

- Affordability – no fee proposal over £5000 (inclusive of VAT and expenses) will be considered
- Evidence of understanding of the issues involved as demonstrated by the quality of the statement of approach submitted
- Suitability of the proposed approach as demonstrated by the schedule of how the contact times will be broken down
- Evidence of relevant experience and track record
- Level of fee sought