

Promoting Careers in Computing Education: Sharing Practice



Contents

Introduction	1
Executive Summary	2
Invited Keynote	5
Theme 1: Showcases	7
Introduction	
Oxford Brookes University	
Oxford Brookes University – module description	
Swansea University	
University of Birmingham – module description	
University of Hull	
University of Glasgow	
University of Kent	
University of St Andrews	
Theme 2: Student and teacher experiences	45
Introduction	
Douglas Fraser (University of Glasgow)	
Adam Kurkiewicz (University of Glasgow)	
Maggie Tuohy (Douglas Academy Glasgow)	
Computing in the Classroom: 360° of experience at Kent	
Kiah Warner (Oxford Brookes University)	
Theme 3: Transition to teaching	55
Introduction	
Manchester Metropolitan University, Faculty of Education	
Portsmouth University: Teaching route in Computer Science	
University of Liverpool: Promoting Careers in Teaching Computer Science via Outreach Activities	
Theme 4: Continuing Professional Development	69
Introduction	
Universities: The missing link?	
Swansea University: Case Study Technoteach	

Introduction

Amongst the recommendations in the recently published Royal Society Report 'After the reboot: computing education in UK schools' (The Royal Society, 2017) is a recommendation 'higher education providers need to promote careers in computing education to a wide range of students'. In response to this, the Council of Professors and Heads of Computing held an open workshop to reflect on this theme, organized by Oxford Brookes University and the University of Kent.

A number of universities run modules under the Undergraduate Ambassador Scheme (UAS, 2018) which are designed to give students direct experience of computing education in schools, from a teacher's perspective and to encourage them to consider careers in teaching. Some universities are also offering courses that combine computer science and education, leading to a qualification that includes Qualified Teacher Status.

The aim of the workshop was to bring together university staff, teachers and students to reflect on experiences so far of promoting careers in computing education and what next steps might be taken. People thinking about setting up these kinds of modules and qualifications, or with a more general interest in approaches to promoting careers in computing education, were encouraged to participate as well as those who already had experience in this area.

The workshop took place on 27/28 March 2018 at the University of Kent at Canterbury, attended by academics, students, teachers and representatives from Computing at School hubs. The workshop programme included a keynote talk from Simon Peyton-Jones, a member of the Royal Society Report Working Group, and case study presentations from the perspectives of academics, teachers and students, reflecting the diverse ways in which 'computing in the classroom' is already incorporated in undergraduate curricula. Contributions from a multidisciplinary perspective and the broader context of Computing at School and Continuing Professional Development for teachers also featured in the programme.

David Duce, Clare Martin, Oxford Brookes University
Janet Carter, Sally Fincher, University of Kent

April 2018

The Royal Society (2017) 'After the reboot: computing education in UK schools'.
Available at: <https://royalsociety.org/topics-policy/projects/computing-education/> (Accessed: 11 April 2018)

UAS (2018) The Undergraduate Ambassadors Scheme (UAS).
Available at: <https://uas.ac.uk/>. (Accessed: 11 April 2018)

Executive Summary

In his keynote talk, Simon Peyton-Jones highlighted the gap between the target for teachers of computing as set by the government and supply. Currently the supply of computing teachers is around 68% of the target whilst in biology, for example, supply exceeds the target. The Royal Society's *After the Reboot Report* (The Royal Society, 2017, figures 13 and 14, p. 62) shows that UCAS admissions data for teacher training are much lower than in other science subjects such as biology, physics and mathematics. The percentage of full-time first degree leavers in computing working in education is significantly lower than in other science subjects. It is against background such as this that the Royal Society Report included a recommendation that 'Higher education providers need to promote careers in computing education to a wide range of students'.

A key point made at the outset was that in order to secure the supply of high calibre undergraduate students, teaching of computer science in schools needs to be very high quality, and hence there is an onus on universities to deliver high quality teachers back into the supply chain. Even if school leavers do not go into higher education, there is a wide need across industry for people with computer science skills at all entry levels.

One of the ways in which universities are currently giving students experience of computing education is through modules based on the University Ambassador Scheme. At the time of writing the UAS web site lists 175 departments in 52 universities offering a UAS module, of which 21 (in 21 universities) are in computing. [<https://uas.ac.uk/universities/participants-2/> accessed 5/4/2018] Module names vary between departments, but for simplicity the title 'computing the classroom' is used in this summary.

Following the workshop, the organisers gathered materials and synthesised key items of discussion and concern. These are collated and presented here in four themes.

Theme 1: Showcases details what a number of departments are doing to promote careers in computing education. It provides a bank of experience on which departments entering this space might draw when setting up new modules, and from which departments already running modules of this kind might find confirmation that the challenges they have faced are not unique, and might also draw inspiration on how modules might be refined.

Theme 2: Student and Teacher Experiences contains individual contributions reflecting on the reactions of a number of individuals to either taking computing in the classroom modules or hosting students in school placements.

Theme 3: Transition to Teaching, explores pathways that currently exist for entering the teaching profession and how these relate to or are embedded in computer science degree courses. The relationship between computer science departments and education departments is also touched upon.

This is a complex area, not least because of the number of pathways available and differences between the English, Scottish, Northern Irish and Welsh systems too.

A number of universities are offering or planning to offer computing degree programmes that include elements that lead to graduation with Qualified Teacher Status. Some of the issues are explored in this theme.

Theme 4: Continuing Professional Development (CPD) explores ways in which universities are working alongside teachers to enhance professional skills. It was realized that the outset of the workshop that the problem of shortage of supply of computer science teachers is much broader than delivering more graduates into post graduate education courses.

There was strong participation from people involved in the Computing at School (CAS) organization and from universities engaging with CAS and providing CPD opportunities (and other forms of support) to teachers in their region. But the coverage of CAS is by no means nationwide and by no means all universities engage with their local school communities at this level. As one speaker put it: universities are uniquely positioned to support this endeavor: they span the country, so have geographical reach and can uniquely provide both subject expertise and support in high quality computer science teaching. There is a significant opportunity for universities to do more in this space.

COMPUTING AT SCHOOL
EDUCATE - ENGAGE - ENCOURAGE
In collaboration with BCS, The Chartered Institute for IT

Shaping how our children learn computing

Myths and from the front line

Simon Peyton Jones
Microsoft Research Computing at School



Invited Keynote

After the reboot: now what?

Simon Peyton Jones, Microsoft Research, Cambridge

In 2014, England launched a completely new Programme of Study for Computing at school. For the first time anywhere in the world, computer science is established as a foundational subject, like maths or natural science, which every child should learn, from primary school onwards. Alongside this new material, the new curriculum continues to emphasise the importance of learning to use and apply information and communications technology confidently and creatively. Similar reforms are under way in Northern Ireland, Scotland, and Wales.

This change presents schools and teachers with an epic challenge. Not only is there a lot of new material (and computing is not the only subject that was reformed) but relatively few teachers have qualifications, or subject knowledge of, computer science.

It also presents universities, university students, employers, and professional bodies with a huge opportunity: the government is actively inviting us to play a leading role in shaping what the new computing curriculum will mean in practice, and how it 'lands' in thousands of classrooms across our nation. What should we teach, and how should we teach it? What exactly does 'computer science' mean for a 7-yr-old? Is it just 'teaching our kids to code'? What precisely is 'computational thinking', and is it a buzz-word or a meaningful educational insight? How can we assess progress and learning in computing?

The November 2017 Society report 'After the reboot' (The Royal Society, 2017) summarises the state of play after three years, and makes recommendations for moving forward. Informed by this work, the talk gave a sense of how the land lies, and some of the opportunities and challenges that surround us.

There is much to do, but everything to play for.



Theme 1: Showcases

Introduction

Theme one showcases the experiences of university course leaders who currently run placement modules in schools in order to promote careers in education. The case studies below are intended to provide a useful resource for other departments when embarking on similar programmes, as well as an opportunity for existing organisers to reflect, share and learn from good practice.

Participants were asked to structure their contributions according to some general headings including:

- module setup
- finding school partners
- what to teach prior to placements
- supervision of students
- what kind of projects do they do?
- assessment
- challenges
- reflection on lessons learnt
- time management issues – for university, teachers and students
- effectiveness (however judged).

Case studies were received from seven universities: Oxford Brookes, Swansea, Birmingham, Hull, Glasgow, Kent and St. Andrews. They provide a broad collection of modules with a variety of maturity levels. All of the programmes are based on the framework created by the Undergraduate Ambassador Scheme (UAS, 2018). As such, they all have an initial training period, which includes practical steps such as obtaining DBS certificates. This is followed by a school placement under the supervision of a teacher mentor, which is overseen by the university course leader. Placement activities usually include a classroom component, lesson planning, and an educational project. Assessment has a number of elements, typically including a teacher assessment, reflective log book, report and presentation. In some cases, such as at Swansea, this module is part of a much wider programme to support computing education in schools.

Challenges

A number of common themes emerged in terms of the challenges faced by course leaders. These included scheduling school placements and visits, as well as matching students to schools according to geography, skills and timetables. There were also shared concerns around moderating teacher assessments. Many universities stressed the importance of maintaining a very good relationship with busy teachers in partner schools, which can be difficult if students are not fully committed to their placements. There were also some challenges that were unique to particular institutions, such as the language problem faced in Swansea, where some schools teach only in Welsh.

From discussion at the workshop, it became clear that there are common patterns of success and challenge faced by leaders of computing in the classroom modules. Key points included:

- Modules are (usually) optional and may be offered in the second or final year and carry a variety of credit weightings. From discussion amongst participants it seems that uptake by eligible students is around 10 to 15%.
- Some students go on to pursue careers in teaching, but by no means all. This is based on anecdotal evidence, rather than hard data.
- Seeking to pursue a teaching career is not the only reason students give for taking the modules
 - Some students are looking to improve their communication skills and see this type of module as an excellent way to do so
 - Some students take the module to 'test the water', a low-cost way to see whether such a career would suit them
- The administrative burden of computing in the classroom modules is not small. At one level there are similarities to industrial placement modules, but there are additional complications for example background checks and managing the risks of a placement going 'wrong', which can have serious consequences for the school involved and the relationship with the university department.
- Modules are fragile – they depend on highly motivated university staff and teachers alike and are often dependent on a small number of individuals, such that career moves can spell the end of the module or the end of a relationship with a particular school.

It was recognized that despite the difficulties, there are many opportunities too. The Guardian ranked 102 UK universities in the subject area Computer Science and Information Systems in a recent league table (The Guardian, 2017), so whilst computing in the classroom may not be appropriate in all contexts, with only 21 departments currently offering a module there is considerable scope for more departments to engage.

There are other ways in which universities encourage students to engage with computing education besides computing in the classroom module. The University of Manchester, for example, enables students to undertake a final year project with a computing in schools, educational materials, context. Examples are featured in a video on the department's web site (University of Manchester, 2018).

References

- The Guardian (2017) University guide 2018: league table for computer science & information. Available at www.theguardian.com/education/ng-interactive/2017/may/16/university-guide-2018-league-table-for-computer-science-information. (Accessed: 11 April 2018)
- University of Manchester (2018) School of Computer Science: Student Projects. Available at: www.cs.manchester.ac.uk/study/undergraduate/experience/student-projects/. (Accessed: 11 April 2018)

Along with this, there is also a strongly held view that computing education is not promoted as a career in the same way that say, software development is. Computing education needs to be promoted as a potential career from the start of the undergraduate experience.

A key point raised was that teaching is not necessarily a career for life as it has been perceived in the past. Nowadays teaching is a career that people move into and out of. Examples were given of people gaining some years experience and then following other career paths involving a high degree of communication skills, as well as people moving into, or back into, teaching in later life. A teaching qualification can act as a career-backstop.

Benefits

All of the universities were very positive about the modules. The feedback received from students and teachers shows a number of benefits. It is a very valuable vehicle for offering insight into teaching as a career, although the conversion rate was variable. As an added bonus, many students value the communication skills gained on the module and the associated improvement in self-confidence. We therefore hope that the body of knowledge presented below will encourage other universities to consider introducing similar initiatives.



Oxford Brookes University

Clare Martin:

cemartin@brookes.ac.uk

School of Engineering
Computing & Mathematics
Oxford Brookes University
Wheatley Campus
Wheatley
Oxford
OX33 1HX



Module setup

Oxford Brookes University (OBU) launched its Communicating and Teaching Computer Science module in 2013. It was created as part of a broader scheme of work to support the Computing At School (CAS) movement's successful reintroduction of Computer Science into the National Curriculum in 2014. Like many computing departments, the (then) department of Computing and Communication Technologies (CCT) at OBU was also conducting outreach work and running continuing professional development courses for local school teachers as part of its role in the CAS Network of Excellence. Departmental interest in the pedagogical aspects of Computer Science was growing, with the introduction of a weekly internal seminar series on this topic, as well as HEA workshops and journal special issues (Crook et al., 2015).

The practical aspects of setting up the module were simplified enormously by the availability of resources from the Undergraduate Ambassador Scheme (UAS) (UAS, 2018). This scheme provided the framework for many important features of the module, such as the selection procedure and assessment schedule. It also supplied important information about Child Protection and Disclosure and Barring Service (DBS) checks. Access to this practical information accelerated the task of preparing paperwork to submit to the University for approval, as well as contributing to the subsequent success of the module.

Finding school partners

Contact with schools was initially made through the obvious routes. For example, schools where outreach work had been performed, connections from the CAS network, and schools sponsored by the University were all approached. The collection of partners has evolved over time. Many new relationships have been formed by students wishing to return to their former schools and colleges.

What to teach prior to placements

Every student is required to undertake a 'special project' during their placement. The content of the project is devised by the student, in collaboration with their school mentor, and can range from running an after school club to designing and leading lessons. Initial runs of the module included training to run a Raspberry Pi workshop so that students could create and deliver a similar workshop of their own as a special project. Training needs have changed over time however, and the varied nature of the projects has made technical workshops on a particular topic less relevant.

Currently, the students are offered a teacher training session which introduces the idea of lesson plans as well as techniques for managing classroom situations. Some of the teaching resources that the students produce are shared with subsequent cohorts with a view to encouraging continuity.

Supervision of students

Before starting the module, students are selected on the basis of an application form and interview. Students are required to rank their technical skills in various topics in order to facilitate matching them with schools. They are also asked to declare any prior experience of working with children or young people. During the module, students attend sessions in the University on a fortnightly basis for training, discussion and progress checks. These meetings also give an opportunity to raise any issues and to propose and discuss ideas for the special project. They are also encouraged to form virtual groups of their own. Some students have expressed a desire to visit each other on placement but this had not yet been implemented.

What kind of projects do they do?

Most projects involve the lower end of the school (Years 7-9), perhaps because they are less involved with exams. Micro controllers, robotics and graphics are common themes. Some examples are illustrated in Figure 1 below.

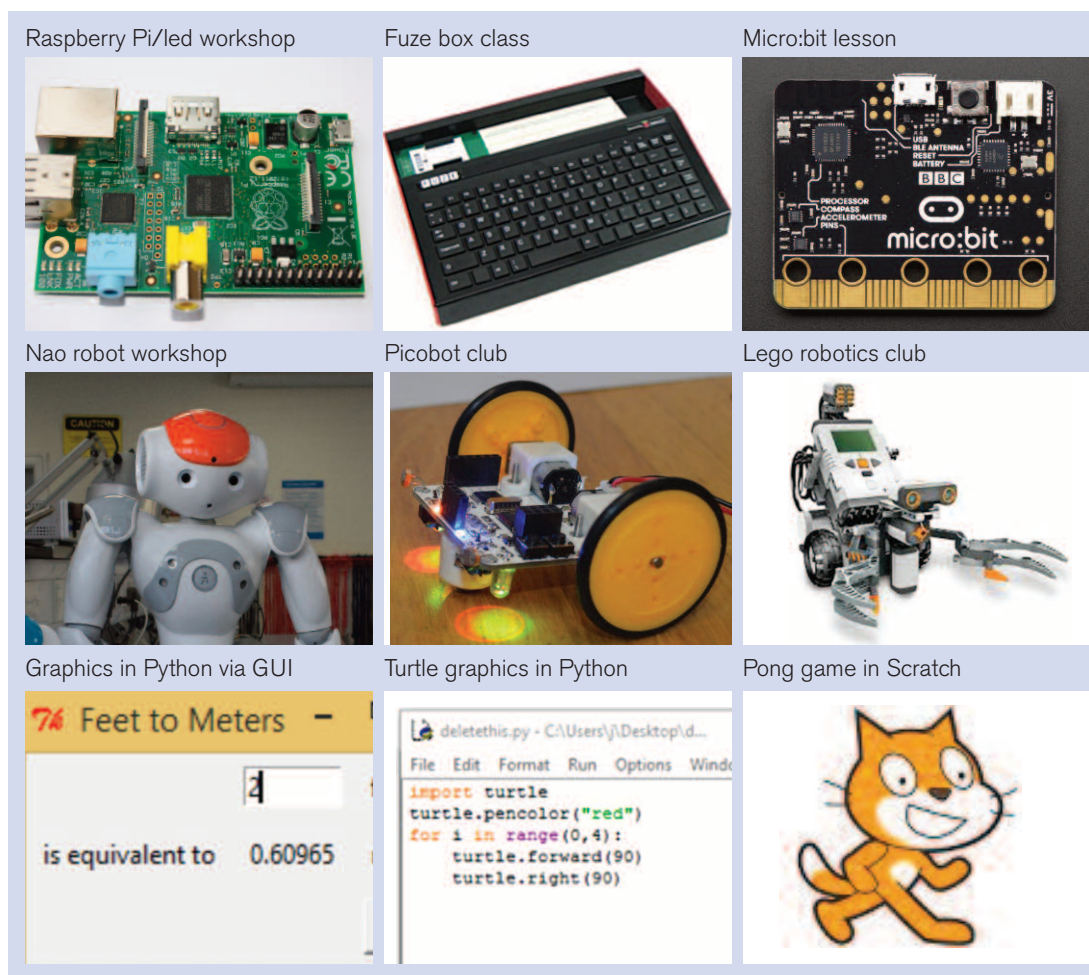


Figure 1 Student Special Projects

Assessment

The assessment follows a standard model with four components: reflective log book, teacher assessment, final report and presentation. Both the assessment structure and associated mark schemes are derived from those supplied in the UAS resources. The presentation event is always a highly stimulating and positive experience for staff and students. The latter seem to enjoy having the opportunity to share the highlights of their placement as well as the successes (or failures) of their special projects.

Challenges

The current selection process is not perfect, and occasionally students are chosen who have taken the module for the wrong reasons. This is a particular concern if it risks damaging the relationship with teachers. Timing can also be an issue, both in terms of finalising the placements and the lack of synchronicity between school terms and semesters. Sometimes there is a mismatch between the number of applicants and available placements. There are also matching considerations: students and schools need to be paired in such a way that the skills offered match those needed. Geography can also be a factor: some schools are far from the University, which brings questions around reimbursement for travel costs. A final issue is the dearth of textbooks about teaching Computer Science in schools. The recommended textbook at OBU is (Hazzan et al., 2015).

Reflection on lessons learnt

This module has overwhelmingly positive feedback from students. Some students progress to careers in education but others are deterred after witnessing the long hours and dedication demanded by a teaching career. Either way, the experience seems to be very successful in building confidence and helping students to consider career choices. The benefits to teachers can be inferred from their assessment scores and willingness to continue running the scheme. In most cases the teacher feedback is positive, which suggests that the students generally make a useful contribution to the classroom. The over-arching theme appearing in students' final presentations is that they want to make learning programming fun!

Oxford Brookes University

– module description

1 Management details

Module title:	Communicating and Teaching Computer Science
Module number:	U08085
Module leader:	C Martin
Level:	6
No. of credits:	15
Mode of delivery:	Classroom based
Pre-requisites:	U08055, U08009
Co-requisites:	
Barred combinations:	
Other restrictions or requirements:	
Timetable information:	11 weeks, available in semester 1 and semester 2

Programme/s in which this module may be taken	Status
BSc Computer Games and Animation (GM)	Optional
BSc Computer Science (SQ)	Optional
BSc Information Technology Management for Business (IC)	Optional
BSc Mobile Computing (IL)	Optional
BSc Network Computing (NK)	Optional
BSc Software Development for Business (WB)	Optional
Computer Science (SD)	Optional

2 Module aims

- To provide undergraduates with an opportunity to gain marketable and transferable key skills including the communication of their knowledge of the subject in a challenging educational environment.
- To give undergraduates a better appreciation of the level of their own expertise in their subject, and to build upon this through the process of explaining the subject's core ideas and concepts to others.
- To help undergraduates learn to address the needs of individuals and to think about methods of presentation which are appropriate to the groups they are working with.

3 Learning outcomes

On successful completion of this module, students will be able to:	<i>Graduate Attribute developed</i>	<i>Other GAs developed</i>
1 Demonstrate communication skills by:	Academic	Critical Self-Awareness
• using a style and content of spoken language which is appropriate for the context and which engages the interest of the audience (individual or group); • listening actively, asking questions, clarifying points and rephrasing others' statements to check mutual understanding; • producing and using written material effectively.		

2 Work with others by:

- clarifying specific roles, negotiating arrangements and agreeing targets for tutoring with appropriate staff at the placement, balancing own views with the needs and views of others;
- establishing and maintaining effective working relationships with teachers and pupils/learners and concluding relationships amicably;
- reviewing progress in working towards targets and request, receive and offer appropriate feedback.

Critical
Self-Awareness

3 Demonstrate organisation, reliability and self-management skills by

- planning, organising and preparing thoroughly for tutoring and completing all necessary monitoring and evaluation documentation conscientiously and punctually;
- managing time effectively;
- taking personal responsibility for completing agreed actions competently, justifying and rationalising decisions made and showing appropriate self-control and self-confidence;
- taking personal responsibility for identifying and meeting own learning and skills development needs.

Critical
Self-Awareness Research;
Digital and
Information

4 Show initiative and creativity by:

- taking independent action where and when appropriate;
- developing innovative and creative solutions to problems and challenges and critically reviewing their implementation;
- provide the pupil with innovative resources or guiding them towards innovative and/or complex resources that will result in explicit educational achievement by the pupil;
- suggesting improvements to practice as appropriate.

Research Academic

5 Identify and understand the educational needs of others by:

- providing the pupil/learner with basic resources or guiding them towards resources that will result in explicit educational achievement by the pupil/learner;
- evaluating and assessing the work of the pupil/learner and give feedback designed to improve pupil/learner performance in the future;
- identifying attitudes, values and motivations that may inhibit pupil/learner educational aspiration and attempting to find ways to overcome these barriers;
- discussing own educational aspirations and achievements with pupils/learners, including what it's like to be a university undergraduate.

Academic Digital and
Information;
Research

6 Demonstrate self-analysis, reflection and critical evaluation by:

Critical
Self-Awareness

- identifying and evaluating own levels of competence in each learning outcome;
- showing the ability to analyse problems and identify possible resolutions with practical action;
- focusing activity on areas of strength and planning improvements in areas of weakness;
- critically evaluating overall progress against initial targets and action plan.

4 Outline syllabus

An initial training session provides the student with an introduction to working with children and conduct in the school environment. A competitive interview system is used to match students with appropriate schools and a specific teacher in the local area, and each student selected is given a chance to visit the school they will be working in before commencement of the unit. The student will be required to spend half a day a week in the school for 9 weeks of the semester, or equivalent (27 hours). There are no formal lectures associated with the module, and that wherever possible or appropriate the students' own ideas and learning will feed back into the content of their activity as they become more experienced. The students are given a handbook, logbook and guidance notes at the start of the module that will offer them additional contacts for support and suggestions on finding teaching resources to use in their special projects. The teachers act as the main source of guidance but, in addition, students can also discuss their progress with the module leader, during a series of tutorials.

The students will be involved in the following activities:

- **Classroom observation and assistance:** Initial contact with the teacher and pupils will be as a classroom assistant, watching how the teacher handles the class, observing the level of computing taught and the structure of the lesson, and offering practical support to the teacher.
- **Teaching assistance:** The teacher will assign the student with actual teaching tasks, which will vary according to specific needs and the student's own ability as it develops over the term. This could include offering problem-solving coaching to a smaller group of higher ability pupils, or taking the last ten minutes of the lesson for the whole class. The student will have to demonstrate an understanding of how the level of the computing knowledge of the pupils they are teaching fits in to their overall learning context in other subjects.
- **Special projects:** The student will devise a special project on the basis of discussion with the teacher and their own assessment of what will interest the particular pupils they are working with. The student will have to show that they can analyse a specific teaching problem and devise and prepare appropriately targeted teaching materials, practical demonstrations and basic 'tests'.
- **Extra-curricula projects:** The student may be supervised by the teacher in helping to run an out-of-timetable activity, such as a lunchtime club or special coaching periods for higher ability pupils. The student will have to demonstrate an ability to think laterally in order to formulate interesting ways to illustrate more difficult concepts from computer science.
- **Written reports:** The student will keep a journal of their own progress in working in the classroom environment, and they will be asked to prepare a written report on the special project.

5 Teaching learning and assessment strategy

Teaching methods include:

- Initial short training course
- Discussions with teacher and module leader

Learning activities include:

- Preparation and delivery of teaching materials
- Maintenance of a log book
- Preparation and delivery of a special project

Assessment methods are detailed below and comprise:

- Assessment of log book
- Final report mark
- Evaluation of placement presentation
- Teacher's assessment

6 Learning hours

(10 notional learning hours per credit)

Teaching preparation/independent study	114 hours
Contact hours	36 hours

The contact hours are as follows:

- 27 hours in school
- 3 hours of tutorials with the module leader
- 6 hours of initial training

7 Assessment tasks

7.1 Summative assignments

<i>Indicative assessment tasks</i>		Word count/ length of exam	Learning outcomes assessed	Weighting	KIS category
<i>Coursework</i>					
1	Completion of a log book including the initial observation, daily logs and the special project log, completed using a template that relates to the learning outcomes.	As appropriate for template	1-6	25%	
2	End of module report including a critical evaluation of progress and experiences during the module.	1500-2000 words	3-6	25%	

3	Presentation to the module leader and other module participants on any subject relating to the placement.	15 minutes	1-6	25%
---	---	------------	-----	-----

Written examinations

Specifically, those that require timetabling by the Academic Office (Examinations Team)

%

%

Other

(including practical examinations)

%

%

The remaining 25% of the marks are awarded on the basis of an assessment by the teacher, moderated by the University. This last component will assess the following learning outcomes: 1-5.

7.2 Opportunities for formative assessment and feedback

Supervisors and teachers will monitor the student's progress and will provide formative feedback on appropriate aspects of the student's work.

8 Indicative reading list

Bartlett, S. & Burton, D. (2007) *Introduction to Education Studies*. London: Sage

Bennedsen, Caspersen, and Kolling (2008) *Reflections on the Teaching of Programming*, Springer Verlag, LNCS.

Capel S, Leask M and Turner T (2005) *Learning to teach in the secondary school: a companion to school experience*. London: Routledge.

Cole, M. (ed) (2012) *Education, equality and human rights*. London, Routledge.

Cushing (2013) *AQA GCSE Computer Science Student's Book*, Hodder Education.

Ellis V (ed) (2007) *Learning and teaching in secondary schools*. Third edition. Exeter: Learning Matters.

Glover D and Law S (2002) *Improving learning: professional practice in secondary schools*. Buckingham: Open University Press.

S Leach, (2006) *How to be a Successful Secondary Teacher*, Allen Unwin

Hazzan, Lapidot and Ragonis, (2015) *Guide to Teaching Computer Science*, Springer Verlag. Second Edition.

Scott-Baumann A, Bloomfield A and Roughton L (1997) *Becoming a secondary school teacher*. London: Hodder and Stoughton.

Date module first approved: Jan 2014

Swansea University

Faron Moller

F.G.Moller@swansea.ac.uk

Department of Computer Science
Swansea University
Singleton Park
Sketty
Swansea
SA2 8PP



Technocamps

Since 2003, Technocamps – Swansea University's schools outreach programme – has been providing hands-on computing workshops to inspire, motivate and engage young people with a particular emphasis on girls, given that less than 10% of our undergraduate computer science student body is female. Since 2011 we have engaged with over 40,000 young people, a full 43% of which were girls.

For one 18-month project for the Welsh Government's Department of Education (2014-2016), we were given the remit of delivering a single 3-hour Technocamps workshop in every single secondary school throughout Wales, aimed at promoting computing as a subject both to the school children and their teachers. Whilst we failed to get in to every school due to some resisting our repeated approaches, we succeeded in delivering workshops in over 95% of them; furthermore, the popularity of the workshops led to demands for return visits, and by the end of the project we delivered an average of 9.8 hours of workshops in every secondary school across the nation. For this project alone we engaged with 5000 school children and 800 teachers, and these school-based workshops continue to this day.

All of our Technocamps activity is carried out by Technocamps Ambassadors, many of whom are (undergraduate and postgraduate) students in the Computer Science department; in particular, many of these CS students are involved in the establishment and running of lunch-time and after-school Technoclubs in the schools.

CSC390: Teaching Computing Via a School Placement

Since 2012, Swansea University has offered a 3rd-year module, *CSC390: Teaching Computing Via a School Placement*, which embeds and expands the activities of our undergraduate Technocamps Ambassadors. The main aim of this module is to give CS students a solid impression of the teaching profession and encourage them to consider teaching as a career. In the ten years prior to establishing this module, I have been asked to provide references for only two students applying for PGCE places – and these students' ambitions were to become Maths teachers, not ICT/Computing teachers. Since this module has been in place, usually at least two students each year have gone on

to do a Computing-based PGCE programme. Equally important, each year sees a few students indicate in module feedback that – whilst enjoying the module very much and possibly considered teaching as a career before taking it – they have discovered something about themselves: that teaching is not for them. This has saved the time and expense of them earning a PGCE qualification only to discover through PGCE placements that they would not make use of their Newly-Qualified Teacher status.

As 3rd-year students take only either five or six modules (depending on their programme of study) alongside an individual project, there is a lot of competition in attracting students to this module, particularly given that there are three other very popular optional modules which most students choose. They have to pre-select their 3rd-year optional modules near the end of their second year; and those who select this module have to submit a DBS form at that time to the University.

CSC390 Training Day Programme

- 1 Introductions
- 2 Expectations and concerns
- 3 Your school placement
- 4 Assessment of the module
- 5 In your school
 - Professionalism
 - Subject knowledge
 - Teaching skills
 - Assessment

Buffet lunch / Discussions

- 6 Exemplar practical task
- 7 Code of conduct
- 8 Completing formal and informal evaluations
- 9 Final questions and clarifications

Figure 2 Pre-placement Training Day Programme.

Module setup

Whilst embedding the goals and activities of our Technocamps Ambassador programme, the module we set up was heavily influenced by the University Ambassador Scheme (UAS, 2018). From a standing start, the UAS is an excellent model for other institutions to adopt.

Finding school partners

Due to its extensive programme of school engagement, Technocamps has direct links into every secondary school across Wales and a large proportion of their feeder primary schools (through its *Playground Computing* programme). Hence, we have no problems whatsoever with finding school partners. Indeed, we are more likely to suffer from the problem of failing to enrol enough students onto the module to satisfy the schools wanting to take part in this programme.

In placing students, we try to identify schools that would most benefit from this programme. Many of the teachers who ask to be involved do so as they are struggling to deliver computing lessons due to having no computing background themselves, and thus are appreciative of the support offered by the computer science students and the resources that they bring.

The induction training day

During the week before term starts (the University's 'Induction Week'), the students enrolled on this module get a full-day (9am-4pm) of training. The programme for this training day is presented in Figure 2. This training is provided by a qualified teacher trainer, not a computer science academic, and concentrates on pedagogics and professionalism. It is made clear to the students exactly what they can expect when they go into their school and its classrooms, and exactly how they should present themselves and behave. Exemplar tasks and role-playing exercises are used to consider modes of teaching and how to handle themselves when faced with potentially delicate or disruptive situations.

The school placement

Each student is placed in one secondary school for the whole of the 11-week term, and assigned a teacher-mentor in that school, though they may well be participating in different teachers' classes. The classes they take part in ideally are wide-ranging, both in year group and in subject, so that the students experience teaching to different age groups and experience contrasting styles across different teachers and subjects. However, they will for the most part be participating in GCSE and A-level computing and ICT classes lead by their teacher-mentor.

Students are generally placed in pairs, as they can find it daunting – particularly in the beginning – to go in to a school on their own. This has worked out well for both the students and the schools. However – and particularly for our students who start with a good deal of experience delivering workshops as Technocamps Ambassadors – being assigned to a school on your own is entirely possible.

Some students who take the module express a desire to work with younger pupils in primary schools, so we typically place a couple students in a primary school rather than a secondary school each year.

During the first week in school, the students are expected merely to observe lessons and reflect on the presentation of the teachers and how the pupils react to this presentation. As the weeks go on, though, the students are expected and encouraged to become ever more involved in the lessons, first as teaching assistants helping individual pupils. The level of involvement of the students is at the discretion of their teacher-mentor, and will depend on many factors, particularly the confidence of the teacher in the students being able to deliver the curriculum material given the few lessons in the timetable allocated for this. However, it is almost universally the case that students get at least one opportunity to independently deliver a full lesson during each of the final few weeks of their placement.

It is expected that the students get a free lesson during the school day. However, as well as participating in scheduled lessons, for the module the students are required to organise and lead a lunch-time Technoclub; and to assist in an unrelated after-school activity such as a sports team, a music or drama club, or any other club led by some faculty member in the school. In this way, the students experience the full realm of pupil engagement activities in which school teachers are involved. The Technoclub can be varied, and typically draws on the vast array of workshop resources developed by Technocamps. Robotics activities involving LEGO Mindstorms, the Raspberry Pi, the micro:bit, and/or Arduinos are a common theme, with clubs often created to compete in the Annual Technocamps Robotics Competition.

Assessment

Modelled closely on the assessment criteria of the UAS, the students are assessed on three components:

- 1 A commentary, in the form of a reflective log, on their school experience (30%);
- 2 The production of a 3-lesson teaching resource (40%);
- 3 A report written by the teacher-mentor (30%).

The teaching resource must cover three lessons on one specific topic of the student's choosing, complete with all necessary notes and activities, and assessment material with marking schemes, along with a detailed lesson plan for the teacher. Whilst there is no requirement that these lessons be delivered by the students in the school, quite often the students are given the opportunity to do so; and often the resources are adopted by the teacher-mentor for their own personal future use.

Schools' half-term break

Halfway through the Autumn term, schools are closed for their half-term break. During this week, the students on the module are required to attend a 4-hour session during which they are provided formative feedback on their reflective logs, and provided with guidance on how to develop their teaching resources, in particular how to present lesson plans, assessment material and marking schemes.

Challenges

There are a variety of challenges which we face every year.

Scheduling school placement days. Students taking this module spend one full day each week in their school during the Autumn term. This obviously has to be on a day in which they have no lectures or labs for the other modules they are taking. Fortunately, students only take at most two other modules at the same time; also, the Department works hard on the timetable to ensure that each student has one free day during the week. Hence, it generally proves straightforward to find a day during the week for each student to spend in school. However, the final timetable is not published by the University until just before the term starts, and often suffers from last-minute adjustments.

Scheduling school visit days. As moderator, I visit each participating school (at least) twice: once during the term to ensure that the students' engagement and experiences are progressing as expected, and once at the end to discuss the teacher-mentor's assessment. This can be hugely time-consuming, particularly taking into consideration the remoteness of many of the schools.

Moderating teacher assessments. Whilst teacher-mentors are provided a pro forma for providing formative and summative feedback against set criteria, different teachers provide widely-different marks; as their assessment is worth 30% of the module grade, these can provide an unfair advantage to those students who have teacher-mentors who are generous with their marking, and an unfair disadvantage to those students who have teacher-mentors who are harsh with their marking. Thus, moderation is required, which is facilitated by the school visits I make at the end of the term to discuss with the teachers how the term went for the students and to go over their assessment pro forma and the marks they assign for each assessment category.

Geography. Wales is a sparsely-populated country with a rugged geography and few top-quality roads, and many of our 'local' schools are difficult to get to, taking over an hour to drive to from Swansea, and substantially more by public transport. These isolated schools tend to be the most in need of computer science support – and thus the ones we most want involved in the programme.

However, this then relies on being able to identify students who can (and are willing to) drive to such distant schools, and then reimbursing them for their travel costs.

Language. A number of schools that want to participate in this programme are Welsh-medium schools, which have a particular problem with attracting STEM teachers in general, and specifically computing/ICT teachers. Whilst we have Welsh-speaking students taking the module each year, quite often they ask to be placed in an English-medium school as English is the language they use in their computer science studies. Hence, we find that we have to disappoint some Welsh-medium schools each year, though we typically do place at least one student in a Welsh-medium school each year. This itself presents a difficulty, though, in assessing such a student's work (as a non-Welsh speaker leading the module), as they are naturally allowed – and encouraged – to submit their work in Welsh. Using a translation service leads to grammatical errors being corrected and technical errors being introduced; whereas using a Welsh speaker from a cognate Department to assess the material for me leads to potential inequalities which our (naturally English-speaking) external examiner would not be able to identify.

Effectiveness

There are two main aims we have in running this module in Swansea.

The first main aim is to raise awareness amongst computer science students of the possibility of teaching as a profession. Of course, there are very many tangible learning outcomes and transferable skills, even for those not progressing into a teaching role, which this module very effectively provides: interpersonal and improvisational skills and dealing with difficult or potentially disruptive situations; preparation of presentation materials and development of communication skills; team working and giving and receiving feedback.

Most students who take this module, understandably, do not progress onto a PGCE. However, every year some do, and so this module has created a small but steady pipeline which previously did not exist.

The second main aim is to complement the work of Technocamps in supporting and upskilling the nation's teachers who are charged with teaching computing in schools. The module has been very effective in this, having a great impact on many of the schools who have been struggling, particularly, with the adoption of the new GCSE Computing curriculum.

Furthermore, very many of those who take this module but don't go into teaching still extend the enjoyment they've had in working in schools with this module by becoming STEM Ambassadors and offering to deliver extracurricular computing clubs in their local schools. In some instances, they have recruited colleagues in the companies they join to do likewise, which adds to the impact.

University of Birmingham – module description

Achim Jung

A.Jung@cs.bham.ac.uk

School of Computer Science
The University of Birmingham
Edgbaston
Birmingham
B15 2TT



Teaching Computer Science in Schools (Academic Year 2017/2018) – overview of the module

How does it work?

This is a 10 credit module available to final year BSc and MSci/MEng students. It closely follows the general structure of the national Undergraduate Ambassadors Scheme (UAS, 2018). The module has three components:

- Four two-hour training sessions in the Autumn Term on
 - Overview of the module; the Criminal Records Check (DBS)
 - An introduction to classroom teaching
 - Useful resources
 - Assessment
- Participation in the training sessions is **compulsory**.
- School visits of a minimum of three hours each during the Spring Term. (No visit during schools' *half term holidays and project demonstration week*.)
- Weekly reports, end-of-module report, and presentation (see below).

What might you learn by taking part in it?

You may be interested in a career in teaching and in this case this module is an opportunity to find out whether this is suitable for you. If you apply for a PGCE course after graduation then having done this module will be a big plus in your record. The University of Birmingham now offers a PGCE in Computer Science as does Newman University.

Even if teaching is not where you are headed, the module offers the opportunity to learn some unique transferable skills, many of which are difficult to exercise in the other modules:

- Public speaking and communication skills
- Organisational and interpersonal skills
- Time management skills
- Team-working

- Working in a challenging and unpredictable environment
- Staff responsibilities and conduct Addressing the needs of individuals
- The ability to improvise
- Giving (and taking) feedback
- Handling difficult and potentially disruptive situations

Your time in the classroom

Every placement is different and it is not possible to predict the arrangements at the school you will be working. Primary schools are very different from secondary schools, and the interpretation and implementation of the computer science syllabus depends on school and teacher. In general, schools are reluctant to put you in GCSE or A-level classes because they are very cautious about disturbing students' preparations for the national exams. Consequently, most placements are in Year 9 (age 14) classes or lower.

As a rough guide, you can expect the placement to evolve in three phases:

- Phase I: Getting to know the school, the teacher, and the classes; ad hoc involvement in the practical sessions.
- Phase II: Performing an agreed role in the lessons; taking on specific responsibilities as agreed with the teacher.
- Phase III: Being a reliable colleague to the class teacher(s). Crucially, as this is a requirement, teaching **three lessons** on a topic agreed with the school. The length of a 'lesson' differs from school to school but if it's less than 45 minutes then you will find it difficult to get your material across to the class; in that case ask for a 'double lesson'. Ideally your lessons are delivered to the same class but this can be difficult in schools with two-week timetables. *Early and careful planning is advised!*

In addition to regular teaching, you may be asked to run a lunch-time or after-school club, or you may be asked to offer training to the other teachers, or you may be invited to give a presentation to sixth formers on life as a university student.

Assessment

The assessment for this module consists of four components:

- A weekly **school experience log**, including lesson observations and evaluation of own activities, to be submitted weekly via Canvas (20%);
- An **end-of-module report**, around 2000 words (3000 words for MSc students) (30%), to be submitted after the Easter Break via Canvas;
- A 10-15 minute **oral presentation** (30%) in front of fellow students and two academics during Revision Week;
- An **assessment by the teacher**, moderated by the module coordinator (20%).

The overall aim is to assess the following:

- your ability to acquire and develop key skills;
- your knowledge of a working in an educational environment;
- your ability to observe and analyse;

- your ability to apply knowledge in ways relevant to your environment in an enthusiastic and helpful manner;
- your ability to critically evaluate your own progress.

You will **not** be assessed on whether or not you have shown yourself to be a potential teacher.

The weekly school experience log (20%)

You are required to record your nine placements by filling in a log sheet after every visit (template provided). This should take you not much longer than 10 minutes. Submission is via Canvas (Mondays, 11 o'clock). For each complete logsheet two marks will be awarded.

During the first six weeks, you must on **two occasions** augment the log sheet with a more detailed report on one particular topic. Which topic you choose for this is up to you. Some suggestions:

- The topic of one of the lessons and how the teacher explained it.
- A particular point of mis-understanding in the class and how you addressed it.
- How the teacher structured the lesson.
- How the teacher catered for students of different ability.
- How the teacher controlled behaviour.
- How the teacher dealt with an unexpected situation.

Marking scheme for the detailed report:

- Clarity of description. Remember that you do not need to report everything, but what you choose to report should be done clearly and lucidly.
- Analysis. Your critical and reflective comments on what you did or what you saw.

Each of these aspects will be marked on a scale from 0 to 3. Good performance will normally be awarded two points. The third point is reserved for *exceptional* quality.

The possible six points for the detailed report are on top of the two points for the log form.

In each of the **final three weeks**, you must include in the log sheet the lesson plan you constructed in preparation for the lesson you taught that week.

Marking scheme for the lesson plans:

- Structure of the plan: Layout, level of detail, comprehensiveness
- Pedagogy: How you planned to explain the topic of your lesson.
- Structure of the lesson: For example, the mixture of presentation and student activity.
- Differentiation: Your plans for weaker and stronger students.

Each of these aspects will be marked on a scale from 0 to 3. Good performance will normally be awarded two points. The third point is reserved for exceptional quality.

The possible twelve points for each lesson plan are on top of the two points for the log form.

Total points possible from the weekly reports: $18+6+6+12+12+12=66$.

The log sheets are due by Monday, 11 o'clock. Please submit them via Canvas.

Late penalties: If the log sheet is submitted late, a mark of zero will be recorded.

The end-of-module report (30%)

This report is meant to be written at the end of the semester, after the placement has finished. You should describe the project, or sequence of lectures, that you developed and delivered in the final three weeks. You should describe your initial ideas and how they were shaped in discussions with your tutor. You should then describe how the lessons went and how the pupils reacted to your teaching. You may want to reflect on your lesson plans and how they worked in practice. You should likewise evaluate on your teaching and what you would do differently if you had to teach this subject again. You may also want to comment on the overall experience of taking part in this scheme.

The report should be about 2000 words long, and is due **Monday, 23rd April, at 11 o'clock**. You should submit it via Canvas.

Late penalties: For every day that the report is late, 5 out of 100 will be deducted until 0 is reached.

Marking scheme:

- Structure of the report, spelling and grammar
- Content: e.g. description of the teaching experience
- Development strategy from lesson to lesson
- Critical reflection

Each of these aspects will be marked on a scale from 0 to 6. Good performance will normally be awarded four points. The last two points are reserved for *exceptional* performance. *Note that I will not judge the actual success of your lessons but I will evaluate your professionalism and your own critical assessment of your work.*

Fourth Year MSci/MEng students can only enrol in the **extended** version of the module. This has an additional learning outcome: *demonstrate an understanding of educational research as it pertains to Computer Science*. This is assessed by an additional 1000 words in the end-of-module report which reports on and discusses a published piece of work from the area of computer science pedagogy. I will make suggestions and help with the selection. This part of the report will contribute 10% to the module mark while the 2000 words section that is common with the BSc version of the module will contribute 20%.

Presentation (30%)

You will have to give a short (10-15 minute) presentation to the rest of the class at some point in Revision Week (23rd-27th April), the exact date will be determined once the rest of the timetable for that week has been established. You are free to base your presentation on your overall experience or on your own three lessons as described in your end-of-module report.

For **MSci/MEng students** the brief is exactly the same, in other words, your presentation should not include the findings of your investigation into educational research. This is to make it easier to compare the presentations among each other.

Marking scheme:

- Structure of the presentation, slides (if used).
- Content.
- Delivery.

Each of these aspects will be marked on a scale from 0 to 10. Good performance will normally be awarded seven points. The last three points are reserved for exceptional performance.

Teacher-mentor report (20%)

As noted previously, a report will be written by the teacher-mentor. This will take place after you have completed your school-based half days. Questions which the teacher-mentor is expected to answer include the following:

- Professionalism: attendance and punctuality
- Subject knowledge Interaction with pupils and contribution
- Evaluation of the three lessons
- Soliciting and acting on feedback

Teachers will be asked to mark each aspect with up to four points, and to justify their evaluation. You have access to the questionnaire I am using¹. The teacher evaluation will be moderated by me.



¹ The full module description (2017-18), including links to external resources, is available at www.cs.bham.ac.uk/~axj/pub/teaching/current/tcsis/index.html (Accessed 13 April 2018)

University of Hull

Neil Gordon and John Rayner
n.a.gordon@hull.ac.uk

School of Engineering and
Computer Science
University of Hull
Cottingham Road
Hull
HU6 7RX



Introduction

As a discipline group, Computer Science at Hull has a long record of working with schools and colleges to promote the teaching of computer science. In 2006, we were approached by the Undergraduate Ambassador Scheme (UAS, 2018) about potentially offering a module under their umbrella, as they were looking to support a wider range of STEM disciplines. We decided to work with them, and to offer a module as a way to enhance the communication and other transferable skills of the students and to give them the experience of learning and taking responsibility in an educational setting outside the usual framework of lectures and tutorials.

We developed the module based on the national Undergraduate Ambassadors Scheme which was initiated by author and broadcaster Simon Singh in 2002. The Scheme is supported by the DfES and Teacher Training Agency and is working closely with the Institute of Physics, the Institute of Mathematics and its Applications, the DTI, SETNET and other bodies. Part of the rationale for resourcing it was that it is an effective way to support Widening Participation, Partnership for Progression and increasing the supply of motivated teachers.

Communicating and Teaching Computing (Undergraduate Ambassadors Scheme)¹

This was the module that we developed under the above remit. It includes a number of formal sessions intended to prepare and support our students, as prepare for, then go out into, local school settings to support the teaching of computing. The module requires that the students develop a portfolio based on their experiences in the school, and to plan and deliver some form of lesson content or agreed extension activity.

Numbers on the module have varied year on year, though typically between 6 and a dozen. This does mean the module is considered a small module, and as such requires justifying in terms of resources; we have justified the module based on the value it provides as a way to link to a wide range of local schools.

¹ For module description and formal specification see www.courses.hull.ac.uk/modules/1718/08244.html

Issues and challenges

As the module requires placements in schools, it does provide a number of challenges and issues compared to traditionally taught modules. These issues include:

Arranging DBS

Students require DBS prior to going out to schools. Coordinating this in a timely manner with the campus team who manage this can be problematic. Students applying for the module are advised that the DBS condition is in place in order for them to be able to undertake the module.

Finding placements

We now have a number of local schools and colleges that we regularly work with, though some students identify new ones: particularly ones close to where they live or even studied previously.

Approving placements

Health and safety and risk assessments are required prior to approval, with site visits preferred before a student can attend. The workload related to this is significant, though having UAS modules across other areas on campus means this can be distributed.

Assessment

The assessment generally is not dissimilar to other modules. However, this assessment typically includes the views of the school supervisor/mentor, and so there can be issues if they don't provide an assessment, or where re-assessment is required.

Losing the placement

On occasion, students have been thrown off the placement by the school. This means that having an alternative: either the student choosing another module if that is viable, or having an alternate placement plan (supporting workshops on campus) can be useful.

BSc Computer Science (with Teacher Training)²

In 2016, we were approached by our education department about the potential for offering a 3-year degree programme in Computer Science, with integrated education modules and time in school, to enable successful students to apply for qualified teacher status on completion (Department for Education, 2018). We have been able to design the degree, utilising the core pathway in our Computer Science BSc, with some new education modules and the above UAS module, to offer this route. The degree is an opt-in one, i.e. students start their BSc in Computer Science, then apply to opt-in to the Teacher Training variant sometime during the second half of their first year of study.

The Teacher Training variant includes an interview and DBS process as a condition of transfer. Alongside the Computer Science compulsory modules are new compulsory modules on education. These modules typically run into the summer (trimester 3), to enable the students to gain time on placement in school so they can accumulate sufficient placement hours to be able to apply for qualified teacher status on graduating.

² For the programme specification see www.courses.hull.ac.uk/programmes/1718/081616.html

Other widening participation activities

We offer a range of other support activities for schools and colleges, including: individual student ambassadors able to be allocated and support local schools and colleges; workshops for teachers on computing topics e.g. programming the Raspberry Pi; Cooperating with our local CAS-HUB and briefings on routes into university computing; workshops and visits for local schools and colleges, with topics such as 3D graphics, games programing in Scratch; Graphics programming in Python, AI and Chabots.

Conclusions

The UAS module has proved an effective way to support students who are considering careers in teaching. It has provided a significant number of teachers – many of whom are now in touch with us about workshops and support for their own pupils. The module – and the new degree – offer mechanisms for us to support schools and colleges and to promote the teaching of computer science.



University of Glasgow

Quintin Cutts

Quintin.Cutts@glasgow.ac.uk

School of Computing Science
University of Glasgow
Glasgow
G12 8RZ



Computing Science in the Classroom

The School of Computing Science (CS) at the University of Glasgow has been running a UAS course for CS since 2007, prompted by news of Kent starting one of these. The course has run continuously since then, led by the same person every year bar one, sometimes with another member of staff. Student numbers have ranged from 7 up to 21.

The key academic learning objectives of the course are to develop the students' skills in reflective practice and their communication skills, as well as giving them a glimpse into the field of CS education. At the same time, the students gain experience of the school teaching environment with support from some great teachers, and symbiotically provide valuable support to the teachers and enhance the pupils' experience of CS.

Original motivation

The course started during *CS Inside*, an EPSRC-funded PPE (Partnerships for Public Engagement) project, hosted at Glasgow and initiated because of the global downturn in student numbers in the wake of the dot.com bubble bursting. The project developed a number of Unplugged-style activities but directed at 13-15 yr olds making subject choices (whereas the original Unplugged activities were for primary children). Our activities aimed to demonstrate the computer science inside everyday technology familiar to the pupils. The activities, like Unplugged, were active, hands-on, and often kinaesthetic. They were a revelation to teachers in Scotland (who had been teaching CS continually since the 80s, but had generally fairly dry curricula and teaching methods) and elsewhere. One teacher trainee said 'I never knew you could teach CS this way', by which he meant, 'in an exciting way'.

Teachers wanted more workshops, but the CS Inside project had of course a limited duration. One of our main motivations for setting up the course was to get our ambassador students to create new workshops broadly in the CS Inside style.

Common to the general UAS motivation:

- We were also aware that our students had no real opportunity to see what school teaching was like. At best, they might have a final year project that built a piece of technology for use in teaching, and could trial it in a classroom – but no opportunity to experience teaching itself.

- Some teachers (though certainly not all) struggled to make the subject exciting, and a student in the middle of a CS degree, often having undertaken a placement with a 'cool' company like Google, has the ability to be a strong motivating influence.

Structure

The broad structure of the course has remained the same over the years, although adjustments have been made as a result of feedback, our learning, and resource limitations.

This is a 5 ECTS course – or roughly 100 notional learning hours. Up to around 30 of these hours are in university sessions, 27.5 are in schools, and the remainder in journal writing, workshop creation, and preparing the final submission. There is no exam. As I write this, I realise that maybe the course is becoming a little overloaded.

The following table outlines the major phases of the course:

May Application	Invite students from Level 3 (out of a 4 yr programme) to apply for the course. Involves a very short application form and a 10 minute discussion (technically an interview). Get the police disclosure process started here, before the summer vacation.
Sept Wk 1 Kick-start	Level 4 classes start in Wk 2. We make use of Wk 1, with 90-120 minute sessions at 9am every day, to kick-start the course. Students experience an interactive/kinaesthetic workshop led by me, and then practice leading them themselves. We practice observing and giving feedback – and students start an on-line journal in which they record what they are learning about teaching and CS education.
Sept/Oct Meet teachers	Students meet their teacher for the first time, at an evening event (6-8pm) run at the University. The aim is to compare timetables, to decide which year groups to target and what content might be of interest. I pretty much leave the dialogue here entirely up to the teachers, who have always seemed very competent at doing this.
Oct-Dec, Jan-Feb In school Weekly seminars	This is the rest of Semester 1 up to Christmas, and half of Semester 2. Students spend this time visiting their schools, amassing around 27.5 hrs of contact time in classes. Teachers told us initially that a school day had 5.5 hours contact. Hence the UAS 10 half-days amount to this figure. They also attend a 1-hr weekly seminar session led by me.
Wk 23 (Feb) Submission, completion evening	Midway through 2nd semester, they submit a range of items for course assessment: their journal, compiled over the course duration; the workshop they created and presented in their school; a 1200 word reflective essay on the key learnings they have taken from the course. There is a second evening with their teachers, the day after the submission, where they give a 5-minute presentation demonstrating their reflective practice, and they have a paper-based display of their workshop for all the teachers to look over. Level 3 students can attend to see what the course is about. It's an opportunity, really, to celebrate all their work.

What do the students do in schools

The only requirement on the student visits is that they must present one existing workshop (as a way of practising their presentation skills) from the likes of CS Inside, cs4fn, CS Unplugged etc.; and they must create a new workshop of their own, in the active / kinaesthetic style, and present it at least once, preferably more often.

Other than this, we leave it to the teachers and students to develop their way of working together. Over the years, these are the most common forms of working we've seen:

- Observer – for the first few classes, the student may just observe, to get a feel for the teacher, teaching methods, and the pupils.
- Classroom assistant. For any practically based activity, an extra pair of hands is a huge help to a teacher – working on, for example, programming or databases classes. While the language may be new, the student is usually quite competent enough to pick up the new language at short notice.
- Ambassador for the subject, or for university. The student may be asked to give a talk about themselves and the path that has led them to this point. This will usually involve talking about cool placements they may have undertaken, and also about university life, and what kinds of things a computer science student gets up to. This can be **very** motivational, and should not be missed.
- Sixth yr (Advanced Higher – like A-level) tutor. Pupils taking Advanced Higher (like the second year of an A-level) undertake a solo project of their own devising. The teachers often don't have great expertise in all the areas that their students may be touching on, and so the ambassador student can be a great help technically.
- Classroom teacher. Sometimes, the teacher delegates quite significant teaching to the student. This shouldn't really happen, and/but I often only hear about it after the event. However, the student can achieve a great result and have a big experience by leading a chunk of lessons, over and above the minimum requirement of the workshop they create.

It is inevitable that every student's experience is different. Some schools are very open to the ambassador and make use of him/her in creative ways in as many lessons and year groups as possible, without great concern about the curriculum. Others limit the ambassador much more, perhaps to a particular teacher / year group / class. This will sometimes be because of timetabling, but also perhaps because of a fear of overloading teachers. Yet others are very bound to the curriculum, and it's hard for them to give time to the ambassador.

Reflective practice – a key learning objective of the course

Much of the course is based around the notion that the students should be developing their skills in reflective practice. To be honest, this is a bit of shock to most of them. It is clear that some are so used to the acquisition of facts as the only purpose of a university course that the idea of developing *one's own ideas* is a struggle.

A key part of the reflective practice is the requirement for the students to keep an on-line journal. This is *very* low-tech – a forum on Moodle, where they each start a thread (their journal), 'replying' to it each time they want to add a new entry. All students can read each other's journals, as well as course staff – but not the teachers. This permits a level of sharing and honesty in what the students can say about their school visits.

Students are expected to keep a record of what is occurring to them as they progress through the course – whether this comes from their in-school experiences, their in-university-class experiences, or from any other conversations or events. They are strongly encouraged to see reflective practice as focussing on *key events* occurring in these contexts that strike them in some way, and then to

investigate *why* they were struck, and what to do next. This is hard for some students. Journals can end up being an endless boring 'what I did in class today' series – and I try hard to explain why this isn't valuable.

Furthermore, it is hard to demonstrate to the students that they should write up these journals as soon as possible after any serious interactions – because even the next day, the most interesting fine detail is lost.

It is amazing how some students think that nothing has happened in a class, because they simply have not switched on their observing minds, while others are able to both spot interesting happenings and write eloquently about what they can see underneath them.

The weekly seminar class – reflection in action

Prior to our weekly seminar class, I read any new journal posts from the students. This takes 1-2 hours. There is usually enough in these posts to craft a session – I pick out 3-5 themes that are worthy of discussion more broadly across the class.

In the class itself, I will raise each theme in turn, drawing in the journal post author, or authors, to say more about their experience. The theme will be around an issue in teaching/learning/CS, best when there is no obvious right answer – something that everyone can take a view on. Examples might be: questioning techniques, attitudes and beliefs, particular teaching styles, how to motivate the pupils, handling unruly pupils, the good and bad of the curriculum, what is CS, and so on. It seems odd, but there's always something to discuss.

This use of their own material to seed discussion, taking it deeper with the input of more voices including my own, aiming to come to a more considered viewpoint and an idea of next steps, is intended to be a live weekly demonstration of reflective practice. Sometimes it will encourage me to dig out a CS education paper or two for the class to read, for discussion in a future session (although I don't make as much use of this as I could, I realise).

Other reflective activities

The students are encouraged to see that their own reflections in their journal lead towards particular issues, viewpoints and realisations about learning and teaching in CS more generally. This can (occasionally) lead them to further reading in the literature around their topic of interest.

The capstone for their developing ideas is a final report on the course of around 1200 words in which they present the major issues that have arisen for them during the course. In true reflective practice style, these should clearly identify real experiences from their school classroom visits, leading to an analysis, and suggestions for their own next steps as well as, if appropriate, on a wider scale.

On the final evening, each student, or students in pairs (depending on the class size) gives a 3-minute vignette of one key issue that has occurred to them – again, event(s), analysis and next steps. With luck, these issues can strike a chord with the teachers present, and a vigorous discussion ensues! One year, a teacher wrote the next day that the students had captured exactly the challenging discussions that were going on right then in school staff rooms across the country.

Overarching learning objectives

Initially, the idea of academic learning objectives, while obviously required for a formal course specification, was not high on the agenda. Primarily, the students were getting an experience of a teaching environment, from the perspective of a teacher, not a learner, and communication skills in a broad sense was also noted. This was enough.

As the years have progressed, a touch more formality has crept in, with the clear focus on reflective practice as a key skill of a teacher, and in fact of any worker not in a formal didactic education process.

I am regularly aware that exposure to education research generally, and CS education in particular tends to come in only through my contributions to the seminar session. I make it clear that there is plenty known about CS education that is rarely shared with teachers at any level – but I do not specifically direct the students to that research, or only rarely.

I would love to do all of teaching practice and reflective practice mentioned earlier, AND an introduction to CS education, but in truth, the course is already on the point of becoming overloaded.

Assessment

The components of assessment, in brief, are:

- 25% Workshop: the materials used to deliver the workshop, and advice on how to lead it.
- 25% Final reflective report
- 20% Journal
- 10% Final evening presentation
- 10% Course leader conduct evaluation (based on attendance and seminar participation)
- 10% School teacher conduct evaluation (a tick sheet and comment box)

Perceived benefits

- Students get a great insight into what school teaching is like. **I should hasten to add that this does not necessarily help with teacher recruitment – only a small number each year opt for teaching.**
- They vastly improve their presentation skills, so they tell us. One year, a student told me that he had to present the next day to a panel from IBM – ‘it’ll be a scoosh compared to the fourth year class I had last week’, he said. A key piece is about making complex ideas understandable to school pupils across a range of ages.
- Pupils get an alternative view of the subject. With the best will in the world, the majority of school teachers can’t be aware of the latest cutting-edge goings on – whereas the ambassadors will either have been on a cool placement or be doing something at the edge of research for their final year dissertation project. A number of the ambassador students over the years have said that they only came to university to study computer science because of the ambassador we had sent to their school years before.
- Teachers get an invaluable pair of helping hands. Classrooms are much like a university lab session, during practical activities, because, like universities, schools haven’t adopted better ways of teaching the children. Hands are up all over the place – and so having another ‘tutor’ in the room is a huge help.
- It’s a great class to lead, from the university lecturer’s point of view, particularly if he/she is interested in CS education. Such a rich source of insight comes from the ambassadors into what is happening in the classroom for teachers and pupils.
- Students do realise that this is the first class, for many of them, where they are being asked to come up with their own understanding of a topic, their own, well-reasoned, viewpoint. This is a revelation. They discuss widely amongst themselves, out of class. The course becomes a kind of hobby – not like any other course. They don’t begrudge the quite long hours, because (I think) they see real value in it.

How we recruit schools

We started with an existing set of schools whom we invited into the university periodically for evenings relevant to schools, and who then came to regular CS Inside teacher CPD evenings. From this core, and as the course has grown in size (particularly in the last 3-4 years), we have made use of a local teacher-led CPD group to broaden our net of contacts.

Some pupils go back to their old schools – if we had no contact there, this was a way of generating one. This was a big route early on – but we have a much larger out-of-town contingent in our degree programmes than originally.

Final observations

Creating a reflective, communicative environment. I learn all the students' names before the course starts. We sit in a circle every week. I obviously value their input. This is very very different to them and creates the right atmosphere to enable open sharing about what they're seeing in schools.

Pick up when the teachers' busy times are. I have adjusted the structure of the course slightly over the years to match the best times for teachers. December is hopeless – Xmas events mess everything up. Starting early is best as October and November is the best time for good learning opportunities.

Have the courage of your convictions when interviewing students. If you don't think a student is going to be a good ambassador, tell them and discourage them from taking the course. They'll be messing up a real teacher and real pupils if they take a slack attitude with them into the school. It's no joke.

University of Kent

Janet Carter
J.E.Carter@kent.ac.uk

School of Computing
University of Kent
Canterbury
Kent
CT2 7NF



Module setup

Our module is run under the auspices of the University Ambassador Scheme (UAS, 2018) and has been in place since 2007. The module specification¹ has been through all the Kent QA procedures in order to be approved. The module was set up by a member of staff who has since retired, so the person running it now was not involved in the initial approval process. It is important that staff running the module have an understanding of how schools work.

Ongoing motivation

- CAS curriculum changes
- Outreach
- Providing a different experience for students
- Supporting teachers with the new curriculum content
- Providing an insight into teaching as a career
- Providing role models for school pupils

The structure of our module

- At the start of the Autumn term students initially submit a 500-word document stating what they want to get out of the module and what they want to give back.
- After this they have an interview, during which they give a 5-minute presentation to an imagined audience on any computing-based topic; we are looking for students who won't panic in front of a room full of teenagers. We also ask practical questions about their location, transport, and what type of school they would ideally like to be placed in.
- Students are accepted/rejected for the module. Most students choosing the module appear capable of rising to the challenge, so only a couple are rejected at this stage each year.
- DBS checks are done.

¹ www.kent.ac.uk/stms/documents/modules/2013-2014/computing/undergraduate/CO646-15-20Feb07.pdf
(searched 1 March 2018)

- Students are assigned a school and must make contact before Christmas to negotiate their visit times and class allocations.
- Students visit their schools weekly during the Spring term.
- We hold 4 fortnightly discussion lectures to talk about issues arising in school, special project selections, and arranging visit times. The first is held prior to students visiting their schools.

Practical issues

A lecture-based module has an economy of scale; there are marking constraints, but a few more students in the lecture theatre doesn't create more work for staff. Unlike a lecture-based module this module has a significant time multiplier per student: each student needs to be interviewed prior to acceptance; each student requires a placement visit; each student has to do a presentation. In Kent, students are placed anywhere from Dartford to Dover so travel time and the funding of travel expenses need to be considered.

Finding school partners

This initially feels daunting, but schools' liaison staff both within the school and within the partnership office have contacts, other staff have contacts in schools their children attend. Some students have their own contacts at their old school or college. Once a few contacts have been established it becomes easier to create new ones, as many schools operate consortia and are happy to facilitate new contacts. Once the module has been running for a while it is likely that teachers will change schools and this creates the possibility of keeping the module in their old school and bringing it to their new one.

What to teach prior to placement

In the first discussion/training session students need to know about:

- education today
- their role in the school
- different ways of learning
- strategies for working with teachers & young people
- preparing themselves

Supervision of students

Students attend the four discussion sessions but the main supervision is undertaken by the school teachers; students are not allowed to be left alone with a class. There is also a placement visit by the module convenor. This facilitates discussion with the contact teacher and allows the convenor to see the student interacting in the school context.

What kind of projects do they do?

Special projects are negotiated between the student and the teacher. Some examples of things our students have done in the past:

- arrange a trip to bring a group of pupils to campus
- give a talk about university life to 6th formers
- teach a small group of G+T or strugglers separate from the main class
- design and teach curriculum-based lessons
- run a lunch time or after school club

Assessment

Assessment follows the UAS pattern.

The students write weekly logs about their visits. This coursework component comprises the 10 weekly logs which are submitted in three batches. There are markschemes for each set of logs: weeks 1-2; weeks 3-6; weeks 7-10. This is 25% of the overall mark.

The teacher assessment (UAS form) is a further 15%, along with the student's written report (35%) and presentation (25%).

Challenges

Challenges include:

- matching students to appropriate schools they can actually get to
- maintaining contact with some teachers
- moderating teacher evaluations (visits help)

Reflection on lessons learnt

You have to adapt and make changes as the module progresses each year in order to head off problems. It isn't sensible to wait until the following year to make changes; if things don't work well for a school they won't take students in the future.

Initially the module had a cap of a maximum of 10 students. As time progressed and our university rules about the minimum number of students enrolled on modules changed the numbers cap was withdrawn; this may be sensible for lecture-based modules but not for external facing ones such as this. It is important to try to keep to a sensible limit for the number of students.

Time management issues

Placing students can be a tricky business. Students have other modules with teaching slots that limit their availability to visit schools. Schools have strict timetables that mean no flexibility. With a large catchment area of schools, transportation has to be considered.

Staff observing students have to find a schedule that works. Even if two students are placed at the same school they may be attending different days, which will entail separate visits to the same school. It all needs to be carefully planned.

DBS checks can take a long time to come through. Some areas take a couple of days and others several months.

Effectiveness

This is difficult to judge. Students enjoy the module and schools like having students in the classroom. It seems to be a win-win situation. Student feedback comments include:

'I enjoyed the fun experience of teaching a group of students in ICT. It was a unique experience that helped me to develop my skills outside of my degree.'

'Schools experience has been fantastic and has opened my eyes to different types of careers path not touched upon previously at university.'

'Personal reflection logs have cemented in my mind how much I have learnt and experienced on this module.'

'This has been my favourite module of my degree!'

'The whole experience was fantastic – the lectures were really helpful and re-assuring, talking to others helped lots. The school itself was good – I really enjoyed helping teach the new curriculum to students. The logs were a good exercise and helped us to reflect on what had happened.'

- Some students use the module as a means to decide whether or not they want a career in teaching.
 - A number of students every year progress to a PGCE.
 - A number of students realise that teaching isn't for them without making too big a commitment to that pathway.
 - A few of students claim to have chosen us because this module is on offer.
- Some local students like to be ambassadors in their old school.
- Some students apply for our CS programmes because there was an ambassador in their classroom.

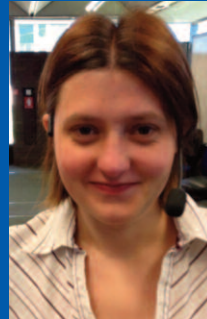


University of St Andrews

Ruth Letham

ruth.letham@st-andrews.ac.uk

School of Computer Science
Jack Cole Building
North Haugh
St Andrews
Fife
KY16 9SX
Scotland



Module setup

The 'Communication and Teaching is Science' module (University of St Andrews, 2017a) is an interdisciplinary module, run within the Faculty of Science. It was developed with collaboration between the Schools of Physics & Astronomy, Chemistry, Biology, Mathematics & Statistics, and Geography & Geoscience, with input from Simon Singh, who co-founded the UAS (UAS, 2018), and members of the University's Widening Participation team. The module first ran in 2007/2008, and was well received by students and staff. Following the initial success, the School of Computer Science joined the module in 2009/2010, with the School of Psychology joining subsequently.

The module is administered by a single academic school that coordinates all the tasks between all participating academic schools. This task can be migrated to any participating academic school, and currently lies with the School of Physics & Astronomy. Each participating academic school has their own 'departmental representative' who is responsible for the day-to-day student interaction with their own students. For various logistical reasons, including financial commitments and securing placement schools, each academic school is permitted up to 10 students to enrol on the module.

A partner module, 'Communication and Teaching in Arts and Humanities' (University of St Andrews, 2017b), was developed in 2010/2011.

The aims of both modules were to:

- provide our students with the opportunity to improve science communication skills,
- provide our students with an opportunity to gain further employability skills,
- allow our students to experience something of the work of school teachers,
- strengthen our links with local schools, including in the widening participation agenda,
- assist science teaching in local schools, encourage the next generation of young scientists

Finding school partners

Initially, schools were selected based on proximity to the University or on our widening participation criteria. Being located in a small town, finding suitable and accessible placement schools could be difficult. Any placement school must be within reasonable travel distance and be reached easily by public transport. The availability of placement schools is a contributing factor to cap on student enrolment numbers, however, since the module is interdisciplinary, several students can be placed

within at the same school within different departments. Each academic school maintains a knowledgebase of primary and secondary schools and teachers they have successfully partnered with. Each year, the department representative contacts these schools and teachers to see if they are willing and able to place a student for their particular subject. This knowledgebase evolves over time as teachers move and different schools engage with outreach activities.

What to teach prior to placements

Much of the learning on this module is done 'on the job', with students being expected to learn from their own research, classroom observations, and teaching practice. Prior to this, students are provided with general pedagogic and subject-specific reading regarding current educational issues. This can include links to governmental websites (Education Scotland, 2018a), and grass-roots teaching organisations (Computing At School Scotland, 2015), as well as textbooks and journals. The students are also provided with a lengthy induction, comprising talks on the Curriculum for Excellence (CfE) (Education Scotland, 2018b), managing classroom behaviour, and general teaching communication techniques. Throughout the semester students are required to attend seminars provided by guest speakers and tutorials delivered by their department representatives.

Supervision of students

Supervision of students is shared between the academic and placement schools. Each student is assigned a 'mentor teacher' within their placement school who is responsible for monitoring the student's performance and behaviour whilst on placement. The department representative within the academic school is responsible for monitoring and supervising the student's progress in relation to their learning objectives and coursework submissions. The mentor teacher and department representative may need to collaborate or confer to ensure the student is proceeding successfully.

What kind of projects do they do?

Each student undertakes a 'special project', which they design and develop in collaboration with their mentor teacher and department representative. The projects should span approximately 1 to 3 hours of teaching, and generally comprise the introduction of a programming concept and a practical programming activity to reinforce that concept. Students may choose to focus in depth on a narrow topic, such as conditionals, or provide a shallower introduction to a broader concept, such as Artificial Intelligence. Some of the technologies students have used include, web technologies, Scratch, Visual Basic, and micro:bits.

Assessment

Assessment for these modules is 100% coursework, and currently comprises 4 components:

- **Special Project Proposal.** A written proposal for the student's special project, outlining the content, timelines and pedagogic relevance of the project. This is submitted early in the semester and is marked by their department representative.
- **Presentation about the Special Project.** An oral presentation about the planning and implementation of the project. This is delivered towards the end of the semester and is marked by a team of department representatives.
- **Teacher Assessment.** An assessment of the student's performance in the classroom in a variety of competencies. This is completed by the mentor teacher at the end of the placement and is converted into mark by the department representatives.

- **Final Report.** A written reflection on the placement as a whole, demonstrating what the student has learned over the course of the semester. This is submitted at the end of the semester and is marked by a representative for a different academic school.

Challenges

It is important that students on this module are fully committed to completing it to as high a standard as possible. Placement schools benefit from hosting students, but must also put in work and make adjustments in their schedules to accommodate this. The University also has a financial investment in this module as it pays for students' PVG checks (mygov.scot, 2018) checks. It is an ongoing challenge to ensure the correct candidates are enrolled on the module, and that the module is advertised correctly to the students and placement schools.

A challenge that applies to all team-taught modules, particularly those that are interdisciplinary, is ensuring consistency of experience for all students. This challenge is amplified by the addition of the mentor teachers' input, and the differences in placement schools that students will encounter.

Reflection on lessons learnt

In my view, the most important lesson that we can learn from our experience so far is to communicate and document expectations to all involved. Students, lecturers and schools must all be able to make informed decisions about their participation in the module and be clear on their roles and responsibilities.

References

- Computing At School Scotland (2015) *Computing At School Scotland*. Available at www.cas.scot/. [Accessed: 19 March 2018]
- Crook, N., Duce, D. & Martin, C. (2015) 'Communicating computer science – lessons from recent history'. *Brookes eJournal of Learning and Teaching*, 7(1). Available at: <http://bejlt.brookes.ac.uk/issue/vol-7-issue-1-july-2015/>. [Accessed: 11 April 2018]
- Department for Education (2018) *Get Into Teaching*. Available at: <https://getintoteaching.education.gov.uk/explore-my-options/teacher-training-routes/university-led-training/university-led-undergraduate-training/degrees-with-opt-in-qts>. [Accessed 11 April 2018]
- Education Scotland (2018a) *Scottish education system*. Available at: <https://education.gov.scot/scottish-education-system>. [Accessed: 19 March 2018]
- Education Scotland (2018b), *What is Curriculum for Excellence?* Available at [https://education.gov.scot/scottish-education-system/policy-for-scottish-education/policy-drivers/cfe-\(building-from-the-statement-appendix-incl-btc1-5\)/What%20is%20Curriculum%20for%20Excellence?](https://education.gov.scot/scottish-education-system/policy-for-scottish-education/policy-drivers/cfe-(building-from-the-statement-appendix-incl-btc1-5)/What%20is%20Curriculum%20for%20Excellence?). [Accessed: 19-Mar-2018]
- Hazzan, Orit, Tami Lapidot, and Noa Ragonis (2015) *Guide to teaching computer science: An activity-based approach*. Springer London.
- mygov.scot (2018) *Protecting Vulnerable Groups (PVG) scheme*. Available at: www.mygov.scot/pvg-scheme/. [Accessed: 19 March 2018]
- UAS (2018) *The Undergraduate Ambassadors Scheme (UAS)*. Available at: <https://uas.ac.uk/>. [Accessed: 11 April 2018]
- University of St Andrews (2017a) ID4001 *Communication and Teaching in Science, Module Catalogue*. Available at: <https://portal.st-andrews.ac.uk/catalogue/View?code=ID4001>. [Accessed: 19 March 2018]
- University of St Andrews (2017b) ID4002 *Communication and Teaching in Arts and Humanities, University of St Andrews Module Catalogue*. Available at: <https://portal.st-andrews.ac.uk/catalogue/View?code=ID4002>. [Accessed: 19 March 2018]



Theme 2: Student and teacher experiences

Introduction

The brief to contributors to theme two (students, teachers or pupils), who have been involved in school-facing modules, either as an ambassador or as a host, was to reflect on their own experience. They are written from the individual's own experience, from their own point of view, in their own voice. They tell stories of genuine involvement, giving reasons for becoming involved in education, showing what's enjoyable and the parts they found challenging. The theme was not designed to enable general conclusions to be drawn, but rather makes a contribution to the general narrative of promoting careers in computing education from the viewpoints of a number of individuals.

Douglas Fraser (University of Glasgow)

My experience with Computing Science in the Classroom at the University of Glasgow was an overwhelmingly positive one. The format and the flexible approach to the course matter are drastically different from any other offered within the Computing Science program and provided me with an enjoyable and rewarding experience.

When considering which elements of the course I enjoyed the most a few key aspects come to mind. The approach taken towards the weekly, hour long, seminars allowed them to become my favourite part of the course. Early on our Professor established an environment of free discussion based on relevant topics which the class were most interested in, guiding or refocussing the discussion when needed. Should there be no issues which the students wished to bring up directly, then attention was brought to interesting entries, or common themes which had been identified from the student journals. By following this approach these sessions became an exercise in debating. Often due to the situational nature of teaching there is no objectively correct answer to a debate, challenging students to form arguments to back up their own interpretation of the behaviours being observed in the classroom. At the end of the debate on a subject the discussion was often turned towards suggesting methods to improve the discussed issue in future situations and the opportunity is usually taken to link the issue to further reading on the topic being discussed.

My experience working with my placement teacher was a very rewarding one and I was allowed a great deal of flexibility in how I wanted operate when in the classroom. Initially I was granted time to observe and become familiar with the level of work being performed by students before becoming more involved in the running of the classroom activities.

Throughout my placement I was used in a variety of different roles within the classroom. I was regularly utilised in a classroom assistant role to help the students complete assigned work, clarifying how elements of the curriculum might be used in further education and in industry where possible. In addition to this I gave presentations talking about what life was like at university both as a student and when studying Computer Science. Finally, the course requires the running of two different class workshops, one of which should be planned entirely by myself. I feel like this allowed me to get a lot out of the placement as I could experience many different aspects of working in the role of a teacher.

Having finished the course over a month ago I have been afforded an opportunity to reflect upon the skills which the course has allowed me to develop. The course certainly offers an opportunity to students which is unparalleled within the course listings in the University and from speaking with my peers this is something which was very much welcomed by the group. While only a very small minority of students in the course go on to pursue careers in teaching straight out their undergraduate – estimated at about 10-15% of the 20-person class – the chance to develop skills in reflecting upon previous events, presenting arguments and public speaking attracts a consistent, enthusiastic class with a good atmosphere. Personally, I think that the course has helped give me a stronger understanding of the classroom environment, how to approach both teaching – and learning – new Computer Science concepts and has further developed in me some useful skills which will aid me in the workplace in the future. While I do not intend to pursue a career in teaching in the immediate future due to many reasons, I found the course very valuable and having completed this ambassador project I am very interested in working with a future employer to enhance computing education through other means.

Adam Kurkiewicz (University of Glasgow)

I am a second year PhD student at the University of Glasgow in the field of transcriptomics, which is entirely tangential to the field of computer science education, and is not the reason why I'm here.

I'm here because I took Computer Science in the Classroom in 2015/2016, and I'm considered to be one of the students for whom the course 'worked', as it inspired me to start my own computer science and mathematics after-school club, which has been running every Tuesday evening since September 2017, and attracts students from three Glasgow High Schools (two state schools and one private school).

I'm going to say a few words about what in the course worked for me, what didn't, and I'll try to point at a particular worrisome pattern that I, and other students taking the course in my cohort, have noticed in many Glasgow high schools.

As Douglas [Fraser] mentioned in his part of the report, the course has a highly vocational nature, with plenty of 'hands-on' teaching experience with real pupils and real high-schools. I consider this to be the golden standard for running such courses, in the way I consider it to be a golden standard for a programming course to include hands-on laboratory-style programming exercises.

Replacing lectures with a weekly seminar I have mixed feelings about. The idea is that through opening the floor to peer-discussion based on student's journal entries, the students will reflect on and improve their teaching skills. In practice I found this to be helpful only at the beginning of my teaching experience, but after a couple of visits in the school, both me and the pupils found a satisfactory way to work together, and I didn't feel like this sort of 'reflective practice' provided much stimulus for my learning how to teach. What I would prefer is a few lectures based on a selection of research articles on computer science education followed by in-class discussion. This could possibly have enriched the repertoire of teaching techniques I had used in the school more efficiently than peer discussion.

While teaching in the school both me, and my wife, who also took the course, and various other students who participated in the weekly seminar noticed a worrisome pattern in our pupils, which, for the lack of a better word I will call 'failure to generalise'.

Let me give an example of an interaction which happened between me and a 6th year on one particularly rainy Glasgow morning. I was supposed to be teaching students various sorting algorithms, including Selection Sort, but I soon realised that their programming skills weren't sufficient to understand what I was trying to teach them.

I decided to go back a little bit and asked one of the students to implement a prerequisite of many sorting algorithms: the minimum element algorithm, which walks through an array, keeping the current minimum element in a helper variable, updating the variable with progressively lower values, until it contains the true minimum, which we can return at the end of the iteration.

To my great astonishment a student flawlessly typed a solution into the computer right in front of my eyes. I couldn't believe this was the same student who couldn't grasp a simple sorting algorithm just a minute before! I asked her to modify the algorithm to return the index of the minimum element as opposed to the minimum element itself. And she couldn't do it, even with substantial hints.

What turns out to have happened is that the student successfully memorised the minimum element algorithm for one of her previous computer science exams, but failed to generalise the algorithm into a useful abstraction she could successfully apply to a problem of similar type.

The example I just gave is very specific, but I assure you that 'failure to generalise' is a wide-spread phenomenon. I'd like to be able to pin-point the exact cause of this worrisome pattern, but I had not the opportunity to properly study it.

My gut feeling is that the problem is related to the quality of teachers, which is directly affected by the brain-drain of Computer Science graduates into well paid, interesting jobs in the industry, as well as red tape around teaching jobs, such as postgraduate certificate in education.

Another possibility is that failure to generalise is caused by an over-specified syllabus. It's perhaps worth noting that some of the most stimulating computer science and mathematics exams, such as British Informatics Olympiad or British Mathematical Olympiad do not have a set syllabus. This allows for inclusion of innovative questions, which promotes generalisation and abstraction-forming skills in students who undertake such exams.

I hope this perspective on Computer Science in the Classroom and High School teaching is a useful voice in the discussion, and if you'd like to use any of the teaching material I've developed, designed to counter the 'failure to generalise', please follow one of those links:

A really good workshop on virtual machines ('virtual machine' in the sense of Java, not in the sense of VirtualBox), collaboration with Iva Babukova:
<https://github.com/picrin/VMWorkshops/>

Selection Sort and pre-requisites (everything in Visual Basic -- sorry!):
<https://github.com/picrin/SelectionSortVB>
<https://github.com/picrin/practicingFoundations>



Maggie Tuohy (Douglas Academy Glasgow)

Reflection on the Ambassador Scheme with the University of Glasgow

We have been working with the University of Glasgow's UAS in Computing Science for over 10 years. Each year we have taken part in the scheme by firstly attending an evening to meet our ambassador, then welcoming the ambassador into the Department of Computing Science in the school for a period of 10 half days or 5 full days and finally attending an evening of presentations given by all the ambassadors on the module. At the final evening the ambassadors present their new workshop they have created for the school.

The pupils engage positively with the ambassador and welcome the chance to talk to a Computing Science undergraduate and get a feeling for life at university and studying Computing Science.

The pupils enjoy taking part in the workshops and we continue to use workshops that have been created in past years. We also have developed workshops of our own based on the model shown by the ambassadors.

Since we have been in the partnership for ten years we have accommodated a range of ambassadors. Most ambassadors enjoy their experience in school and enjoy taking part in school life and encouraging pupils in their Computing Science studies.

I think it is important that university module leader continues to interview potential undergraduate students before they undertake this module. It is important that the school have an enthusiastic ambassador who can stand in front of an audience and can relate to a younger age group.

We view the partnership with the university as a very positive one and we will continue to support the module. The partnership is very open and the university welcome our contributions to the module and reflections on how the placement has worked out year on year.

Computing in the Classroom: 360° of experience at Kent

The Computing in the Classroom module at Kent is mature, established in 2007. Details of the module can be found in the Showcase in Theme 1. This contribution is from the view of those who take, and have taken, the module and a brief but under-represented voice from a pupil who has been a pupil when Kent ambassadors have taught.

The first contributions are from students currently taking the module in their final year, Khadija and Dan.



Khadija Ali, Daniel Bard, Erin Fitt-Boyland and Ella Wheadon.

Khadija's story

As an international student, I did not learn coding until arriving to University and I was extremely confused regarding what I would like to study. Therefore, it is pretty incredible to me to see the high level of coding being taught to grade 6 and grade 8 pupils in school, especially using an interactive embedded system. It is a much more advanced teaching system than back home, which is incredible to see.

I would like to be able to reach out to the younger generation and offer a clear image of the broad possibilities expected from a path in Computer Science – it's not simply black and white, coding and math – it is the primary base of everything.

Furthermore, I chose this module, as I would love a chance to teach what I have learnt, as Einstein once stated, 'If you can't explain it simply, you don't understand it well enough'. That being said, I was certain I would learn a lot myself through the art of teaching.

When I first went into the classroom I noticed how excited and interested the students were when interacting with the micro:bit. I believe introducing something hands on for the pupils in terms of educating students about code was not only helpful but also extremely enjoyable. Teaching a student on paper what a string is would not be interesting on its own, however showing them the execution of a string and possibility of different usage in code interested them more and involuntarily made them understand it.

I first introduced them to coding the LED to light up with different shapes then taught them how to hard code their own unique shapes. All the students got excited when they saw in real life what their code could do. They were eager to learn and code more in order to see the outcome I followed

by showing coding different features of the micro:bit and we moved onto creating a magic 8-ball for the final lesson which included all of the previous sections.

Finally, for me the biggest challenge was finding the fine line between what I would find simple in relation to what they would find simple. I wanted to challenge them so the work is stimulating but not have them give up because it is too hard.

Khadija Ali, University of Kent student

Dan's story

Following sixth form, I went back to my school for a couple of years to work as a Teaching Assistant (TA) and as part of that, did several cover lessons mainly focused around Maths and Computing. In addition to this, I have been teaching both Swimming and Sailing for many years. From these experiences, I came to realise how much I enjoyed teaching others and imparting the knowledge that I've gained back to them. This includes the challenges of dealing with different kinds of children and needing to understand the topics in question in a deeper level than originally required, since I need to know what way to best enable the understanding of others.

I took the 'computing in the classroom' module to better understand how best to teach complicated topics in a way which is easy to comprehend, and simpler topics in an engaging way which isn't patronising to brighter students. As well as this, I wanted to improve my presentation skills to a wider audience. (I am able to present in some circumstances, but I need to practice to an extensive amount prior to the presentation and also need to follow a script. I wanted to be able to improvise a bit further and to have more flowing presentational skills.)

The module team match up students to schools dependent upon what students say they want, where they live, what transport they have access to, and what the schools require from students. I was assigned my school before the Christmas holidays, and I was quick to e-mail them to establish contact. After not having had a response after a couple of weeks, I e-mailed again. And then a third time. Following this, I got in contact with Janet (the module leader) and we deemed this school as a lost cause as she couldn't raise the contact member of staff either. Janet quickly set me up with another school who, after a couple of attempts, again didn't respond to any replies! Again a lost cause. So that I could have a placement at all, I was swiftly put in contact with one of the University's partner schools about 40 minutes car drive away. Though this wasn't an ideal situation, it was feasible since I have access to a car, however it wasn't ideal due to the early morning commutes on the M2.

Since this was now part-way through the term, it was decided that I would spend full working days with the school for the rest of term as opposed to the normal pattern of a couple or three hours per week. In addition, since I had come into the teacher's lessons halfway through term, they had planned and started to implement the scheme of work and were unable to change much of their lesson plans to accommodate for me as a placement student, so I took on more of a TA role within their lessons. However, this was an advantage since it allowed me to get experience of a much wider range of year groups (years 7-11) within their normal school days as opposed to my being there and presenting in a different way for them. Also, my position as TA allowed me to get greater experience of how the curriculum worked and how computer science is taught within secondary school since it has changed to a great extent since I was taught it.

So, despite the problems at the start of my placement, the solution which was found was one which gave me a fuller experience of working at a school teaching computer science.

Daniel Bard, University of Kent student

The next voice is from Ben, a student who graduated 2014, and what he's done since.

Ben's story

Growing up, I'd always had an interest in youth and children's work and had volunteered in several after-school children's clubs as a teenager, but I never considered teaching as a potential career option.

In September 2013 the Department for Education announced a brand new National Curriculum for Computing, to be taught in all schools by September 2014, which greatly increased the Computer Science skills that are taught all the way down to KS1. This was announced just as I returned from a year working in industry at Cisco Systems in San Jose, California where I was part of a technical team working in systems architecture on business-to-business solutions. While I really enjoyed the work, I realised that the office environment and the technical work wasn't really what stimulated or challenged me, but I was unsure what else was out there. The different style of practical and assessment the Computing in the Classroom module persuaded me to 'just try it out'.

It was that January that I started the Computing in the Classroom module and schools, especially primary schools, were desperate for Computing trained teachers. I spent 10 weeks in a Year 4 class at St Edmunds School, Canterbury teaching them programming through the use of Lego Mindstorms Robots. It started with 2 sessions of observation to get an understanding of the class (and settle my own nerves), followed by a session of building the robots, then 7 sessions of programming the robots starting with simple moving, to moving in squares using repetition, to stopping when reaching an object, then the final session creating a maze with the tables on the floor for the robots to navigate. At the same time as I was working with Year 4s, the Year 8s did the same thing in the upper school, just showing how far the skills have moved in the new curriculum.

Form 4's Lego robots: project with the University of Kent

This week, the children in Form 4 have begun an eight week Design Technology and ICT project in association with the University of Kent. The University has kindly recommended and seconded a final year student – Ben – to come into school and work with the children on a project which will see them working collaboratively in pairs to design and then build a Lego robot and then to programme the robot using the *Lego Mindstorms* programming software. Once the robots are complete, the children will learn to programme and control the robots' movement.

We had a wonderful opening session in which the children learned to combine the various Lego pieces to best effect, testing their models to check if they needed any modification or changes.



On completion of the Computing in the Classroom module, I decided to give a teaching career a go and started on a PGCE course after graduating and I was fortunate enough to receive a BCS Teacher Training Scholarship for the duration of my training. Once I had finished my PGCE I took a job at Northfleet School for Girls, which was one of my placement schools, and really enjoy being able to offer fun and exciting opportunities to get young girls enthused about learning Computing. After two years, I was made Head of Department for Computing. I'm currently pursuing CAS Master Teacher status, and I'm also involved in training other teachers from around the country in Computer Science and programming knowledge through the PIXL organization.

I have realized that one of the most powerful ways to get pupils interested in Computing is having university students come in to run sessions, as the pupils quickly identify the wealth of knowledge that students bring. This is my second year taking students from the University of Kent and pupils have loved the different activities that they bring. This year we have Erin joining us, who has worked with the Lego Mindstorms Robots with our highest ability year 7 group who have been profoundly engaged right from the start.

Computing in the Classroom changed my thinking from 'computing career, youth leader hobby' to 'teaching career, programming hobby'.

Ben Goodwin, Computing Head of Department, Northfleet School for Girls

Erin's story

When taking the Computing in the Classroom module, my placement was set at Northfleet School for Girls. I happened to attend the school from 2006-2011 as a pupil myself. I have also been fortunate enough, to have Ben as my mentor. Having Ben being a graduate student from the University and me being an ex-pupil from the school it's given us a lot of ground for conversation. I've also benefited from him taking the module in the past, and for him to understand what is expected of me when on placement.

Erin Fitt-Boyland, University of Kent student

When Ben took the Computing in the Classroom module in 2013, he taught Ella when she was in year 4. As we've heard, Ben graduated, did a PGCE, and is now a teacher taking placement students himself. He mentored Erin. Meanwhile, Ella is now in year 8 and was taught by Khadija during her placement this year: thus bringing us around a full 360°!

Ella's story

When I was in year 4 we had to learn simple programming. Ben came into our class with lots of Lego robots. One of the things we had to make the robots do was move in a square; it was how we learned about loops. We had students in the class in year 6 and 7 as well. This year we had Khadija teaching us Python using micro:bits. This felt like the first real programming we had done, since year 4 was dragging and dropping, although we knew the concepts. Code combat in years 6 and 7 doesn't count, as typing the first few letters is enough for it to pop up all the suggestions for you.

We like having students in class because it makes lessons a bit different and lots more interactive. We can see our results more easily and it is more interesting than writing things in an exercise book. The students are current and have interesting ideas because they are not constrained by the syllabus.

Ella Wheadon (age 13), St Edmund's School pupil

Kiah Warner (Oxford Brookes University)

Challenges

Understanding different topics in computing curriculum

The computing curriculum covers a wide range of topics from coding in scratch to e-waste. When studying the scheme of work for each year, it became apparent of the topics I was unaware of due to a lack of knowledge on these topics. I was able to communicate with the teachers about topics I lacked knowledge of and read over these topics so I was prepared for the next lesson.

Special Project

When gathering information about the scheme of work for each year, it was finding relevant activities or lesson plans that I was comfortable to teach.

Change in curriculum

The focus of teaching in the time I was there as an ambassador was mainly on assessment lessons. With such focus on assessment, observations became similar to other lessons as pupils would be revising or completing their exam for assessment. The focus of coding in years such as year eight and nine are mainly focused the second term of school.

Successes

Using school resources to devise special project

The school provided a number of resources for students to use such as micro:bits and fuze boxes. The fuze box provided resources about how to create a lesson with different activities such as stimulating traffic lights. I suggested to start a coding club where students are able to apply their knowledge to a creative activity. I started a coding club with year 8 by using a basic coding language called fuze basic. It gave me the opportunity to learn a different coding language and learn a new skill.

Understanding the role of a teacher

It was insightful to see the role of a teacher about what happens beyond the classroom such as planning and discussions about the curriculum. I found it useful to see how teachers teach the same topic to different classes and how they differ. The teachers discussed how helpful it was teaching the same lesson as they were able to reflect on their lesson. They are able to see what worked well and what needed to be improved for the next lesson.

Experience led to applying for Initial Teacher Training

From the ambassador scheme and a teaching internship, I have decided I would like a career in the teaching profession. I have successfully secured a place on PGCE School Direct.

Theme 3: Transition to teaching

Introduction

Contributed by:

Tig Williams, CAS South East Regional Centre

Eleanor Overland, Manchester Metropolitan University

In order to give context, it is worth noting that no matter where you start, there are a number of routes into teaching. There are 5 main routes, which can cause confusion as key aspects differ. There are some differences between England, Northern Ireland, Scotland and Wales, though these are not elaborated here.

- Some are school-led and some are Higher Education institution (HEI)-led. Information is available (Department for Education, 2018a) and a comparison of routes can be found at (Department for Education, 2018b). For some routes, bursaries and scholarships are available for shortage subjects. For computing, trainees might be eligible for a £26,000 bursary if they have a first, 2:1, 2:2, Master's or PhD. For trainees with a 2:2 or above, they may be eligible for a tax-free scholarship of £28,000 from BCS following a successful application (British Computer Society, 2018).
- PGCE (University based)

Students study for a year (or two depending on programme) at a university with school placements with a minimum number of hours in the classroom and assignments in order to pass. A minimum of 120 days is spent on placements in school under the guidance of curriculum mentors who are all experienced classroom teachers. Time is also spent in university, under the guidance of curriculum tutors, who have extensive school teaching experience. In addition to placements, students will be assessed on academic assignments and the courses will carry credits at Masters level which can be used to continue to a professional Masters degree in education. The number of credits varies depending on the provider. Some providers offer a PGDE which has a greater academic requirement and results in additional Masters credits.
- PGCE (School Direct – SD)

School Direct is a school-led teacher training route which allows schools, in partnership with an accredited teacher training provider, to recruit and select the trainees they want with the expectation that they will then go on to work within the school or group of schools in which they were trained (although there is no guarantee of employment). SD trainees can be salaried or non-salaried. The accredited teacher training partner is usually a university, so academic requirements and Masters level credits are similar to those for a university based PGCE.
- SCITT (School Centred Initial Teacher Training)

Networks of schools that have been approved to run school-centred courses are known as SCITTs. They provide practical, hands-on teacher training, delivered by experienced, practising teachers based in their own school or a school in their network. 'SCITT' is also a type of school-led course, similar to the non-salaried School Direct option. Some SCITTs work in conjunction with an awarding body to provide a postgraduate level of academic award but these are not usually a full PGCE. Awards vary between SCITT networks.
- BSc with QTS (Qualified Teacher Status)

These courses generally take three to four years full-time, depending on the number and length of school placements. Bachelor of Arts (BA) or Bachelor of Science (BSc) degrees are most common for those hoping to become secondary school teachers. Degrees with opt-in QTS – this new undergraduate route allows students on selected courses to incorporate teacher training partway through their degree course. Successful students will graduate with both a degree in their subject and the recommendation for QTS.
- Teach First

Teach First is a charity working to end educational inequality. They are building a movement of leaders who inspire young people from low-income communities to achieve their full potential. They do this by supporting applicants to become influential classroom leaders through their Leadership Development Programme. The programme offers a two-year, paid position in a school where they build the skills and experience to become leaders in all sectors of society and may progress to jobs outside of teaching.

- Computing as a Specialism

Not all universities or school based providers have specialist staff to support computing as a specialist subject. At primary level, computing is just one small aspect of the curriculum. At secondary level, Qualified Teacher Status with a specific focus on computing is relatively recent so not all providers have specialist staff to support the subject and may have very small computing cohorts. Some providers are not able to offer the subject at all due to low numbers. All providers host open events where this information is made available.

- UK Wide Variations

Although routes into teaching are similar across the UK there are important distinctions. Scotland and Northern Ireland only offer University led routes into teaching, either through a four year undergraduate route or a one year PGDE (Scotland) or PGCE (NI). Qualified teachers from other areas of the UK may be eligible to teach in other regions by registration with the appropriate teaching council. This tends to be with a recognised PGCE although having QTS from a school based route can be sufficient with additional evidence of experience. For more information, see:

- Education Workforce Council, Wales (2018) <https://www.ewc.wales/>
- General Teaching Council for Scotland (2018) <https://www.gtcs.org.uk/>
- General Teaching Council for Northern Ireland (2018) <https://www.gtcni.org.uk/>
- Teaching Regulation Agency for England (2018) <https://teacherservices.education.gov.uk/>

One of the difficulties for undergraduates is confusion around the different routes into teaching and awareness of routes even within their own institution.

Some universities have introduced an optional education module which can be taken as a unit within a degree. This is not a teaching qualification but allows students to undertake a placement in a school and experience the pedagogy of their subject in practice. They may undertake delivery of a subject specific lesson and write a report about the experience. This has several advantages.

- 1 It introduces undergraduates to teaching as a potential career.
- 2 It may clarify if teaching is or isn't a suitable pathway for particular individuals, thereby avoiding non-completion.
- 3 It introduces the students to their own education faculty helping increase retention in the university.

A barrier to current groups of undergraduates to teaching may be a poor experience of computing education at school which may have been absent, or poorly delivered. We need to explain to our undergraduates that the teaching of the subject is now maturing and the school experience of computing is becoming rich and interesting. Whilst Scottish schools have delivered a computing aspect of the curriculum for some time, for other areas of the UK the developments in computing are more recent. The changes are currently fragile and can only be maintained if we can recruit specialist teachers with the subject knowledge to teach in the classroom. The shortage of skilled computing teachers has reached the point that many schools have non specialists teaching computing at Key stage 3 (pre GCSE), with specialists teaching Key Stage 4 and 5 (GCSE and A level). The recent Royal Society Report, *After the reboot: computing education in UK schools* (The Royal Society, 2017), reports that from 2012 to 2017, England met only 68% of its recruitment target for computing. This can have an adverse impact upon the children's view of the subject as a viable future career so we need more to consider this career path!

The last and most difficult issue is financial. A good computing student can graduate with a very healthy salary e.g. (Britton, 2018), appearing 7th in the list of salaries for degree subjects compared to 19th for education. If they train to teach there is potentially a £28000 scholarship or a £26000 bursary (these bursaries are to train in England) (Department for Education, 2018c). Bursaries available in Wales are smaller, Northern Ireland and Scotland offer limited bursaries by application but have smaller or no course fees. Following training, teacher salary tends to be the same for all subject areas and follows the main teacher pay scale, with additional payment being at the discretion of the headteacher or for additional responsibilities. Many computing teachers are quickly gaining management posts due to the shortage of specialist teachers and so are achieving higher salaries.

Graduates with qualified teacher status are not required to stay in the profession as bursaries are currently awarded for completion of training courses not long term service to teaching. Teaching qualifications and experience in schools are an excellent way of developing communication skills, organisation, collaboration and many other 'soft' skills valued by a range of employers. Within computing, graduates may become qualified, teach for a few years and then choose to progress on to more lucrative career paths. A short term approach to having a specialist teacher in schools may actually support non-specialists within the schools in their own subject knowledge development and create a more sustainable delivery of computing within schools.

Retraining

Currently, there is a range of support on offer to retrain or increase subject knowledge support for non-specialist teachers or graduates in similar, but not exact, disciplines.

Subject Knowledge Enhancement (SKE) courses

Subject Knowledge Enhancement (SKE) courses are intensive programmes for graduates who need to develop a greater depth of subject knowledge and understanding prior to a PGCE or other initial teacher training course. Each course is carefully designed by subject experts to develop the necessary skills and subject knowledge to teach the subject across the 11-16 age range. These are nationally recognised qualifications, fully supported by the NCTL and DfE, designed to address the on-going shortage of specialist teachers in subjects such as computing. Bursaries are available for eligible applicants and there are normally no fees to pay.

Post-ITT Subject Knowledge Enhancement courses

Subject knowledge 'conversion' courses are available for current non-specialist teachers of computing, such as those run by Computing at School Regional Centres.

Recommendations

- School developments in the computing curriculum need to be more widely shared and understood at University level and a greater sense of responsibility established to both support schools and provide qualified teachers to ensure substantial and sustainable change.
- Undergraduates in computing related degrees need to be aware of teaching as a potential career and the funded teaching qualifications available to them. These opportunities should be represented prominently at employability events alongside other career opportunities.

- Teaching qualifications should be promoted as a professional development opportunity and a rewarding opportunity to support sustainable computing in schools rather than a lifelong commitment to the teaching profession.
- Faculties of Education and School based teacher-training providers need to work more closely with University Schools of Computing and Computer Science to support students in their applications onto teaching courses.
- Candidates for teacher training should be aware of the variations between qualifications and providers so they are able to ask the right questions to find a course that best meets their needs.

Structure

The following parts of this theme of the report describe and illustrate various models and approaches. Firstly from Manchester Metropolitan University's Faculty of Education, one of the country's largest providers of Initial Teacher Training, then two approaches to incorporating teacher training pathways into undergraduate courses, contributed by the Portsmouth University and the University of Liverpool. The latter's approach is in partnership with Liverpool John Moores University who deliver the teacher training aspect of the course. The University of Hull's contribution to Theme 1 includes a discussion of their approach to incorporating QTS in an undergraduate computer science degree programme (a joint development with the university's education department). The Royal Society Report, Recommendation 6 (The Royal Society Report, 2017, p9) encourages continuation, and if successful, expansion, of initiatives to develop degree course with QTS.



Manchester Metropolitan University, Faculty of Education

Eleanor Overland, Manchester Metropolitan University
e.overland@mmu.ac.uk

Our computing provision

We are one of the largest providers of Initial Teacher Training (ITT) nationally. We offer a specialist PGCE in Computing (Core and School Direct), computing as specialist options for Undergraduate Primary Education and PGCE Primary. We have also just started to offer an 'opt in' route to Qualified Teacher Status (QTS) joint with our school of computing for BSc CS students.

Although we have large numbers we still suffer from under-recruitment similar to national figures (only 68% of target reached last year). This is a similar pattern with all of our partnership providers in computing and nationally it is the lowest performing in recruitment of all curriculum subject areas.

Initial Teacher Education (ITE) courses at Universities run on narrow margins and are in danger, particularly where numbers are small. School based routes may not have the specialist computing support or provision that University providers are able to give. We provide PG units for local SCITT providers but these are not subject specific.

Developing subject knowledge

We believe confidence in subject knowledge is essential to provide the highest quality Newly Qualified Teachers (NQTs) into the profession. We have a specific focus on computing, particularly computer science at GCSE and A level and we have removed ICT from the title and assessment criteria of our course. Trainee teachers are required to audit their subject knowledge as they progress through the course and address any gaps. The trainees with the best subject knowledge secure posts very early on and are in high demand. All computing trainee teachers secure a post by the end of the course.

For those with dated knowledge or narrow specialisms we recommend the subject knowledge enhancement course (SKE). Ours is face to face in the summer prior to the PGCE, BCS also offer an online option with a focus on programming. Students need to audit their skills first to ensure they select an appropriate SKE for them. Time for subject knowledge development is limited within the main PGCE.

Peer teaching is a useful strategy to take full advantage of student's differing strengths and specialisms. They work collaboratively to support the development of subject knowledge up to A level and share resources and references widely between the cohort.

Working with undergraduates

We guarantee an interview for all our own undergraduate applicants to PGCE courses. Where they have no or limited school experience we provide them with short placements within our partnership schools. We also provide support sessions for completion of the required 'skills tests' and support for GCSE Maths and English equivalence tests. This creates a smooth transition and support for all students to access ITT. We discuss the Subject Knowledge Enhancement Course (SKE) with all applicants and they are offered a SKE place should it be useful for them.

The 'opt in' route has been developed using seed funding from NCTL (National College of Teaching & Leadership) to develop diverse routes into teaching. We also offer this in other shortage subjects

including maths and MFL. This allows students to complete an education unit in year 2 and 3 and school placements (following exams) in years 2 and 3. Student bursaries are less than for PGCE route but the overall course is shorter. It is envisaged this will be a growing model at MMU.

Recruitment

We will only recruit applicants who have a minimum of 50% computing within their degree or significant industry experience. We are engaging with other courses across the University where students are interested in teaching although their degrees may not be a best fit and support them to develop opportunities for students to prepare for teaching. For example, our undergraduate Information Communications have now added units to their course to include programming and they run a code club for local schools.

We also work closely with other local universities who do not have a faculty of education to support recruitment events and career advice.

Working with wider communities

EdLab is a cross-university unit run by the faculty of education to work with local schools and community groups¹. This allows students to work collaboratively across subjects to develop innovative solutions to solving specific problems through education.

Getting more women involved in technology, especially computing, is a challenge for both schools, universities and industry. We have developed the 'Guides Go Digital' badge in conjunction with local Guide units. The trainee teachers have worked alongside the Guides to develop all the content and deliver the workshops for the girls. We have worked with local businesses, particularly UKFast to support the badge development.

At the faculty of education we host the Computing At School (CAS) hub for local teachers. This allows students to participate in CPD alongside practising teachers and some of our excellent BCS scholars even lead some of the training themselves. All trainees are invited to take part in 'teachmeets' we hold at the hub.

The staff in the Faculty of Education have considerable expertise and are well positioned to engage with schools, research and CPD. As a result they are in demand to run CPD events both voluntarily as part of CAS but also paid opportunities with Academy Trusts to provide an additional funding stream.

Working with schools

Over 600 partnership schools host trainee teachers or contribute towards provision with MMU. All of these schools are given funding and support to develop trainees in partnership with Universities. We are selective with regard to computing placements to ensure mentors are trained and able to support development in the subject.

We provide loan of equipment to schools, mainly for trainee teachers to use whilst on placement. Eg Raspberry Pi sets, old PCs, micro:bits, codebugs, VR sets, crumbles, arduinos, We also have a number of group projects throughout the year to enhance the school experience, tackle activities that may be difficult to deliver alone and encourage collaborative planning.



Figure 3 The 'Guides Go Digital' badge as designed by the Davyhulme District Girls

¹ <http://www.edlab.org.uk/>

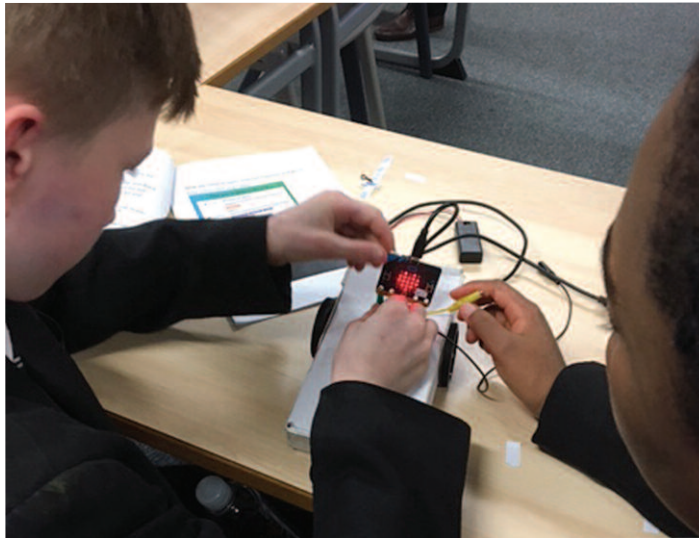


Figure 4 Micro:bit robots would be difficult to build without additional resource and adults to support.

Strategies for Computer Science Departments to build relationships with ITE

Find a faculty of education or ITE provider to work with, not just schools, to provide clear routes of progression for your students. Invite ITE providers in for careers talks etc.

Ensure appropriate information and guidance is available as careers advice for students (not all providers offer specialist computing courses) on different routes and bursaries. Subject Knowledge Enhancement courses are also available to support those with more narrow subject knowledge.

Celebrate the importance of teaching as a profession, the high employment rates and the value of teaching qualifications in other roles in industry.

Consider joint research opportunities. Working with school age youngsters and their teachers provides considerable scope for research projects and there is a growing community of researchers working in this field.

Be aware of the school curriculum (including GCSE and A Level specifications) and how this links to outreach work with the schools. This directly addresses subject knowledge the students will be teaching.

Enjoy the work with schools! Engaging youngsters feeds your undergraduate applications, particularly schools who may have more challenging circumstances where students gain most from additional opportunities and increasing aspirations.

Portsmouth University: Teaching route in Computer Science

Model: BSc degree with option to opt-in to QTS route

Duration: 3 years

Process

- 1 Students from Computer Science and Computing have the option to choose the CUA – Computing Undergraduate scheme at L5
- 2 Towards the end of the Ambassador unit, students have the option to opt in to do the QTS route at L6 in parallel with their other L6 units.

Requirements for student

Need to pass the ambassador unit

Need to be in the Computer Science or Computing BSc degree

Need to pass skills test for both English and Maths, as prescribed by the DoE

Need to 'pass' an entry interview to establish commitment and suitability to take the unit

Timeline

- 1 Eligible students opt in during April (end of ambassador unit)
- 2 End of May = 4 days intensive preparation and training. (Pedagogy, teaching standards, lesson planning.....) Generic morning sessions are shared with the MFL cohort on the same QTS route and afternoon sessions are Computing specific.
- 3 Start June – middle July = student do first block of 6 weeks in schools
- 4 Start September – one week training (on campus)
- 5 Middle September (start of teaching block 1) students are in school 2 days a week
- 6 Twilight sessions are scheduled fourth nightly, for support and mentoring
- 7 June – mid July = second 6 weeks teaching block

Outcomes

- Students will graduate from BSc degree in July
- Students will receive QTS award at successful completion of second teaching block and evidence of all required assessment has been reviewed

Administration

Shared between School of Computing (SoC) and School of Childhood Education Studies (SECS)

SECS arrange for DBS and placement school contracts with teacher mentors

SoC arrange application for Ambassador and QTS route

Staff from both schools share the generic teaching on pedagogy, teaching standards and principles

Soc teach all Computing relevant workshops, seminars and arrange for guest speakers

SoC and SECS staff will job share support for QTS route students while on placement

See visual layout of timeline page 64-65

Schedule may change due to changes in block structure for 18/19

Note: The QTS opt-in route officially starts in MAY 2018

Link to L5 Ambassador unit: [Current Ambassador Unit Handbook](#)

Link to the draft handbook for QTS opt-in route [Handbook for QTS route](#)

Key



3 hour workshop



1/2 day CUA placement



Placement day & evening (4pm-6pm) workshop



School holiday



University non-teaching day

Second Year Ambassador Students L5 2017 – 2018						
Sep	Mon	Tue	Wed	Thu	Fri	
4	Summer					CUA Phase
11						
18						
25						
Oct	Mon	Tue	Wed	Thu	Fri	
2						
9						
16						
23		Half term				
30						
Nov	Mon	Tue	Wed	Thu	Fri	
6	1/2					
13	1/2					
20	1/2					
27	1/2					
Dec	Mon	Tue	Wed	Thu	Fri	
4	1/2					
11						
18	Xmas					
25	Xmas					
Jan	Mon	Tue	Wed	Thu	Fri	
1	Xmas					
8						
15	1/2					
22	1/2					
29	1/2					
Feb	Mon	Tue	Wed	Thu	Fri	
5	1/2					
12		Half term				
19	1/2					
26	1/2					
Mar	Mon	Tue	Wed	Thu	Fri	
5	1/2					
12	1/2					
19	1/2					
26					Good Friday	
Apr	Mon	Tue	Wed	Thu	Fri	
2	Easter					
9						
16						Easter
23						
30						
May	Mon	Tue	Wed	Thu	Fri	
7	Exams					
14						
21						
28			Half term			
Jun	Mon	Tue	Wed	Thu	Fri	
4						
11						
18						
25						
Jul	Mon	Tue	Wed	Thu	Fri	
2						
9						
16						
23			Summer			

Third Year Students who opted in for QTS route 2018 – 2019						
Sep	Mon	Tue	Wed	Thu	Fri	
3						Pre Phase 2
10						
17		Induction				
24						
Oct	Mon	Tue	Wed	Thu	Fri	
1						Phase 2
8						
15						
22			Half term			
29						
Nov	Mon	Tue	Wed	Thu	Fri	
5						
12						
19						
26						
Dec	Mon	Tue	Wed	Thu	Fri	
3						
10						
17		Xmas				
24		Xmas				
31		Xmas				
Jan	Mon	Tue	Wed	Thu	Fri	
7						
14						
21						
28						
Feb	Mon	Tue	Wed	Thu	Fri	
4						
11		Half term				
18						
25						
Mar	Mon	Tue	Wed	Thu	Fri	
4						
11						
18						
25						
Apr	Mon	Tue	Wed	Thu	Fri	
1		Easter				
8		Easter				
15		Easter				
22						
29						
May	Mon	Tue	Wed	Thu	Fri	
6		Exams				
13		Exams				
20		Exams				
27		Half term				Phase 3
Jun	Mon	Tue	Wed	Thu	Fri	
3						
10						
17						
24						
Jul	Mon	Tue	Wed	Thu	Fri	
1						
8						
15					GC	
22			Summer			

University of Liverpool: Promoting Careers in Teaching Computer Science via Outreach Activities

Stuart Thomason, University of Liverpool
s.thomason@liverpool.ac.uk

Outreach Taster Days

During the second semester we offer Computer Science Taster Days within the Department. These are designed to give pupils and teachers a flavour of what Computer Science is like at university. Local schools and colleges visit us in one of our labs to experience a range of hands-on activities across an entire day, from 10am to 3pm. This year we have offered the following sessions to school groups ranging from year 8 to year 11.

- Programming with Angry Birds – Uses the Processing language to move Angry Birds around a map to capture pigs.
- Code Breaking and Ciphers – Introduces the Caesar Shift and Scytale ciphers with a worksheet based activity. For students who are capable, we also have a worksheet based on decoding an Enigma machine message.
- Password Security and Website Hacking – A short lecture that covers good password security practices and shows how websites can be hacked if passwords are weak.
- Lego EV3 Robots – We devote a large portion of the afternoon to using the EV3 robots. They are pre-built into a particular configuration that works with our own custom Python code. Pupils program the robots to navigate around an arena, avoiding obstacles or solving a maze.

Although the taster days are very well received, with repeat visits from schools in subsequent years, they are not currently tied to the school curriculum. Our sessions are based on whatever our PhD students and volunteers want to deliver. As we move to integrate this more fully with our undergraduate module in Communicating Computer Science, we will be better able to package the activities into bundles that support the needs of pupils and teachers. The ideal delivery would allow them to tick off aspects of the curriculum that have been enhanced by the taster day. It would be nice to build up a catalogue of activities that schools can select from, allowing them to tailor each day to their own needs. This is a work in progress that will be completed over the 2018/19 academic session.

The University has a list of target schools as part of its widening participation agenda. Around two thirds of our taster days are delivered to schools who attended in previous years, or who contacted us through word of mouth. The rest are filled by inviting schools from the target list. With each passing year, we receive more repeat custom and need to send out fewer unsolicited invitations.

COMP335 – Communicating Computer Science

The Faculty of Science and Engineering offers three final year modules intended to promote careers in STEM teaching.

- CHEM390 – Science Communication
- ENVS393 – Science Communication
- COMP335 – Communicating Computer Science

Whilst the Chemistry and Environmental Science modules attract around 10 students each, our Computer Science module under recruits, with typically only two students per year from a cohort in

excess of 300. This is probably because Computer Science students at this level really want to study some of the more advanced technical and theoretical modules on offer.

These modules are each worth 15 credits, running 'long and thin' across both semesters. In the first semester all students are pooled together to receive lectures on lesson planning, the National Curriculum (key stages 3 and 4), and STEM ambassador training. They are assessed on their lesson plan (10%), and an essay (20%) that covers 'Challenges of Teaching STEM in Schools' or a similar topic.

In the second semester the students deliver their lesson plans. In Computer Science we align the delivery with our Taster Days, so one of the activities will be designed and delivered by the COMP335 students. Each student must deliver their lesson three times, or more if they want a rehearsal (30%). They also produce a reflective report (30%) and a poster (10%) at the end of the semester. The poster day brings students from all three modules together to share their experiences with each other, and with staff.

Unlike similar modules at other universities, our delivery takes place entirely within the departmental labs. The schools visit us rather than sending our students out into the local area. One of the benefits is that students deliver their lessons to three different schools, experiencing a wide variety of abilities. We have noted that year 8 pupils tend to lose focus over a full day, whereas year 11 pupils are very engaged. Whilst all staff involved in running taster days are DBS checked, our students are not. This saves a bit of administration at the expense of losing out on more realistic school visits. Timetabling is somewhat easier because we can block out every Wednesday, rather than having to negotiate times for our students to visit schools.

Although we require an average of at least 55% in the second year, and interview students prior to module selection, there have nevertheless been occasions where the students have created poor lessons which would impact on our reputation, and in these cases we ask them to deliver one of our existing activities instead. Generally this module has been perceived as an easy option due to a relative lack of contact time and the spread across both semesters, so we have attracted students who underestimate the amount of work involved. As this module becomes more popular, we will be able to better select students with the right motivation and personality for classroom work.

G40E – MEng Computer Science with Education (with recommendation for QTS)

We offer a transfer into G40E during April of the second year. Our course runs across four years and offers a £9000 bursary in both the third and fourth years, which differs significantly to similar courses elsewhere. We launched the course in 2017 and have only one student registered, but this year we are publicising the course (and a career in teaching) alongside COMP335 as part of our general introduction to third year modules. Students will make their module selections by mid-April, when recruitment for 2018/19 will become more clear.

We have partnered with Liverpool John Moores University (LJMU) to deliver the teacher training aspects of the course. In year three, students spend the first semester at LJMU and in local schools. In the second semester of year three and the first semester of year four, students study their choice of Computer Science modules from our portfolio, before returning to LJMU for their final semester. This delivery pattern means that students take our second semester Computer Science modules before the first semester options. In practice this hasn't been an issue since modules are self-contained, particularly in the final year.

Treating the course as a four-year MEng means that students do not have to cram their teacher training into a single final year, leaving their summers relatively free and allowing them to study our Computer Science modules without distraction. However, students need to commit to a course

change (from the three-year BSc) by April of their second year, with implications for funding, accommodation, and living costs. We sell the course as a 'lighter' option than taking a separate PGCE, since an MEng is an undergraduate level degree.

We have experienced teething problems with some of our automated systems, which have emailed warning messages about non-attendance of first semester modules when the student was in fact attending the LJMU sessions. The student was understandably annoyed, but these are technical issues that can easily be resolved. Apart from this, the student is very happy on the course and has passed all teacher training modules so far with marks in the high 60s or 70s.

Reflections on delivery

Overall our experience with both COMP335 and G40E has been mixed. Whilst our taster days prove ever popular, integrating these with COMP335 is challenging when students produce sub-par lesson plans. Take-up of the G40E has been very low, possibly because the traditional PGCE route offers a larger bursary, and perhaps because it wasn't really promoted last year. We have sold the programme this year on the basis that it allows students to stay in Liverpool with all their friends and social life, and eliminates the need to apply again for a PGCE. At the time of writing we don't know how many students we will attract.

We have 360 students entering the third year in 2018/19, so hopefully we can recruit some good quality students to both COMP335 and G40E, and take the opportunity to better align our taster days with the National Curriculum. It should be noted that currently COMP335 and G40E are mutually exclusive due to the delivery pattern across semesters. We might consider moving COMP335 into the second year as a precursor to enrolment in G40E, but this will need significant effort to resolve module dependencies at that level.

In previous years the outreach coordinator, COMP335 leader and G40E director roles have been filled by different staff. This year they have been brought together under the leadership of one person, so we hope to achieve more synergy between these activities.

References

- British Computer Society (2018). *BCS Teaching Scholarships*. Available at: www.bcs.org/category/19065 [Accessed 16 April 2018].
- J. Britton (2018). The degrees that make you rich... and the ones that don't Available at: www.bbc.co.uk/news/education-41693230 [Accessed: 11 April 2018]
- Department for Education (2018a). *Get into Teaching*. Available at: <https://getintoteaching.education.gov.uk/explore-my-options/teacher-training-routes> [Accessed 16 April 2018].
- Department for Education (2018b). *Which teacher training route is right for you?* Available at: <https://getintoteaching.education.gov.uk/sites/default/files/pdf/compare.pdf> [Accessed 16 April 2018].
- Department for Education (2018c). *Bursaries and Funding*. Available at: <https://getintoteaching.education.gov.uk/funding-and-salary/overview> [Accessed 16 April 2018].
- Education Workforce Council, Wales (2018) Available at: <https://www.ewc.wales/> [Accessed 16 April 2018].
- General Teaching Council for Scotland (2018) Available at: <http://www.gtcs.org.uk/> [Accessed 16 April 2018].
- General Teaching Council for Northern Ireland (2018). Available at: <https://www.gtcni.org.uk/> [Accessed 16 April 2018].
- The Royal Society (2017) *After the reboot: computing education in UK schools*. Available at: <https://royalsociety.org/topics-policy/projects/computing-education/> [Accessed: 11 April 2018]
- Teaching Regulation Agency for England (2018). Available at: <https://teacherservices.education.gov.uk/> [Accessed 16 April 2018].

Theme 4: Continuing Professional Development

Introduction

For computing, the importance of teacher learning and development is particularly acute, and as computing is encouraged as a subject ever-earlier in the curriculum, this problem increases. The Royal Society report notes: 'Inspirational teaching begins with "teachers who know and love their subject". For pupils to thrive, knowledgeable, highly skilled teachers need support from the school community' and goes on to recognise that this must involve 'more opportunities for training, dedicated time for CPD, and specialist expert advice to assist teachers with subject knowledge.' An associated imperative for computing education research is to devise, identify, and evaluate successful CPD approaches.

An underlying issue with providing CPD is that it rests on ideas of how, when, and on what evidence, teachers actually change their practice. It is often naïvely assumed that a teacher will change their practice either because they are given new materials, or because someone makes a policy decision that they should do so: that pedagogic change is a straightforward identification-and-adoption task. This ignores the reality of situated practice, where change is always enacted by a teacher within a specific context. Teachers will draw on their own complex of knowledge (subject, personal, professional) in working out a change that will fit. Neither does the naïve view take into account the fact that change is not laid onto a blank canvas. Teachers are already doing something, and to take on a new practice means they must alter their old practice. They must stop doing something familiar and take on something initially alien.

This suggests that 'one shot' interventions will not be effective in this area, and indeed short-term CPD offerings, focused on content knowledge and associated pedagogy, have been recognized as of limited effectiveness (Bell & Gilbert, 1996; CUREE, 2014; Sentance, Humphreys, & Dorling, 2014). Ineffective approaches to support teacher development are not restricted to primary and secondary education. In reviewing 191 papers detailing change strategies in STEM Higher Education, Henderson and his colleagues concluded:

'Two commonly used change strategies are clearly not effective: developing and testing 'best practice' curricular materials and then making these materials available to other faculty, and 'top-down' policy-making meant to influence instructional practices. Effective change strategies: are aligned with or seek to change the beliefs of the individuals involved; involve long-term interventions, lasting at least one semester; require understanding a college or university as a complex system and designing a strategy that is compatible with this system.' (Henderson, Beach, & Finkelstein, 2011)

In this they recognise that change in practice cannot be imposed, by 'transferring' materials or dictating through policy, but must be developed with the teachers and in their context. In secondary education, too, effective CPD is respectful of change as a process. Successful approaches are sustained (of long duration) and focused on aspirations for students. They are based on classroom evidence, and they enable and encourage teachers to collaborate with each other (CUREE, 2014; Darling-Hammond, 2017; Park & Sung, 2013; Sentance et al., 2014; Wei, Darling-Hammond, & Adamson, 2010).

Professor Faron Moller, from the University of Swansea, has understood the necessity for high quality CPD since 2003 and has worked to provide support for teachers throughout the principality. In 2015 he devised the 'Certificate of Teaching of Computing' and, with modest funding from the Welsh government, has delivered it to increasing numbers of teachers. A certificated programme recognises the twin problems of providing sufficient, regular support and also that teachers' on-going attendance at CPD events is fragile: regularising CPD as a qualification gives head teachers additional incentive to provide release. Additionally, the certificate is accredited by the Vocational Training Charitable Trust (VTCT), so can be delivered from any university, without encountering obstacles of internal approval and accreditation issues.

David Rydeheard, from the University of Manchester, in a broad-ranging talk at the workshop, reflected on some wider issues and the crucial role of universities in this space.

Universities: The missing link?

David Rydeheard, University of Manchester
david.e.rydeheard@manchester.ac.uk

The Chancellor announced in the 2017 budget: 'The budget will ensure that every Secondary School has a fully qualified Computer Science GCSE teacher, by committing £84 million ...' ... and schools are either desperate for help to deliver computing, or not engaging with this challenge.

How are these to be linked? Where is the nationwide expertise in Computer Science and the teaching of computing? There is only one real answer: in the universities.

More than this, it is in the universities' own interests to develop computing in schools, so that university Computer Science can prosper, can be delivered at a suitable academic level, and so that the UK becomes a world leader in new technologies.

Some universities are answering this call with a considerable investment of effort, others are less engaged.

We will discuss this crucial role of universities, and how the University of Manchester has responded to this, in co-operation with CAS, to support over 2,000 Primary and Secondary schools, with a wide range of activities for teachers and for schoolchildren, almost every day of the school year.



Swansea University: Case Study Technoteach

Faron Moller, Swansea University
F.G.Moller@swansea.ac.uk

Since 2003, Technocamps – Swansea University's schools outreach programme – has been providing hands-on computing workshops to inspire, motivate and engage young people with a particular emphasis on girls, given that less than 10% of our undergraduate computer science student body is female. Since 2011 we have engaged with over 40,000 young people – well over 1% of the whole population of Wales – a full 43% of which were girls. We have managed to engage with such numbers across such a wide area by establishing Technocamps hubs in the computer science department in every university across Wales.

For one 18-month project for the Welsh Government's Department of Education (2014-2016), we were given the remit of delivering a single 3-hour Technocamps workshop in every single secondary school throughout Wales, aimed at promoting computing as a subject both to the school children and their teachers. Whilst we failed to get in to every school due to some resisting our repeated approaches, we succeeded in delivering workshops in over 95% of them; furthermore, the popularity of the workshops led to demands for return visits, and by the end of the project we delivered an average of 9.8 hours of workshops in every secondary school across the nation. For this project alone we engaged with 5000 school children and 800 teachers, and these school-based workshops continue to this day.

Why we started Technocamps

At the turn of the millenium, we noted that university students starting their computer science degree programme were astonished at how the subject differed from their expectations. It was clear to us then that there were real problems with the teaching of computing in Welsh schools.

In an attempt to understand – and hopefully rectify – the situation, we tried to open up a dialogue with computing and ICT teachers in the local comprehensive schools. However, this proved futile; the teachers were not interested in hearing that there was a problem, as they were doing their level best to teach a subject for which they were ill-equipped. According to the Education Workforce Council for Wales Statistics Digest (Education Workforce Council for Wales, 2017) the number of IT teachers dropped from 797 in 2012 to 704 in 2016 (page 13 of the report) only 39.4% of these IT teachers have IT training (page 15). The trend is disturbing: the 12% drop in IT/CS teacher numbers (and 6% drop in total teacher numbers) over the period 2012 to 2016. (Absolute numbers: 797 → 704 IT teachers, and 16268 → 15296 teachers.) . IT/CS teacher numbers should be increasing rapidly, but instead they are dropping at double the national average.

As it was clear that no amount of dialogue with teachers would solve the evident failings in computing education, we started Technocamps as an activity targetted at secondary school children. The basic idea was to introduce young people to the world of computing which they were not seeing in their schools in a way that would change their perceptions, especially amongst girls who particularly could not see the subject as in any way enticing. Apart from opening their eyes to opportunities that were not being revealed to them, the longer-term goal was for this activity to create ever-increasing demand from the children, their parents, and their schools and teachers for the underlying problems to be addressed.

Through this, we hoped to eventually establish a relationship with ICT/computing teachers upon which we could build. In parallel, we sought ways to involve university students as Technocamps Ambassadors, partly to promote teaching as an option for them to take up.

Welsh challenges

There are 3 million people in Wales, spread out over an area that is literally the size of Wales. In comparison: London has three times the population of Wales concentrated in an area which is 5% that of Wales (giving a 60-fold density); and Birmingham has 40% of the population of Wales concentrated in an area which is 1.5% that of Wales (giving a 26-fold density). This leaves the whole nation vulnerable to the absence of organisations such as Technocamps which offer support. According to a 2015 NESTA Report on digital outreach activities (Quinlan, 2015), regions of England other than London and the North West are proportionally well undersupplied for the number of young people living there.¹ The situation for Wales is worse still.

Secondary schools in Wales have an average catchment area of 100 sq km, with most schools outside of the few city centres covering far greater areas. Furthermore, Wales has a rugged geography with few fast roads running through it, meaning that an hour-long daily one-way commute is not unheard-of for the nation's teachers and pupils. Schools – and their teachers – are very much isolated in terms of geography and, thus, subject support. On top of this, over 10% of these schools are Welsh medium – and more than another 20% are bilingual – and they lack Welsh-medium computing resources.

Technoteach, 2012–2015

As noted above, our ultimate ambition from the very beginning of Technocamps was to address and solve the crisis we noted in the teaching of computing in Welsh schools. To us, this meant two things: in the long term, promoting teaching as a career for computer science graduates; and in the short term, providing support and professional development opportunities for any teachers who may currently be charged with teaching computing in schools.

When the Computing At School (CAS) initiative was started in the late noughties, Technocamps threw its full support behind it – along with substantial resources. The Technocamps hubs throughout Wales encouraged – and typically led – the creation of local CAS hubs, and financially supported and hosted regular CAS hub meetings and an annual teachers conference. These meetings were generally popular; however, this activity ultimately proved to be ineffective as we found the same teachers were coming to each meeting and wanting to do nothing more than what was done in the past as they hadn't had the opportunity in their busy schedule to reflect on what they had learnt and integrate it in their daily practice. Furthermore, this activity was not self-sustaining; once Technocamps stopped hosting and financing these meetings, they stopped happening. The isolation outlined above that teachers face in Wales makes it very difficult for them to take the initiative. Indeed, a heat map of CAS hub activity across the UK exposes the bleak picture highlighted by the NESTA report.

We were heartened, however, by the increasing interest of many of the schools and teachers with whom we were engaging, which gave us the drive to provide a programme of training that would have greater and lasting impact. We thus established Technoteach in 2012, in the form of 6-week, 22-hour modules. In the first week, teachers were required to be granted a half day release to attend an intensive 7-hour afternoon training session (1pm–8pm), which would allow them to 'ramp up' and build a solid basis on which to work. The half-day release acted as well as a minimal investment by the school which demonstrated its commitment to the agenda of upskilling its computing teachers. Over the remaining five weeks, 3-hour after-school sessions (5pm–8pm) were provided to progress their knowledge and skills.

Over three years, we delivered 18 modules (13 for secondary teachers and 5 for primary teachers) to a total of 250 teachers (130 male and 120 female), with 26 of them (10%) being from Welsh medium schools. Whilst this programme proved somewhat effective – and far more so than the

earlier CAS hub activities – it still left much to be desired. Teachers were not assimilating the material through active use. Feedback from the teachers made it clear that they would need time off from their busy school lesson planning for this to be at all possible.

Technoteach, 2015–

In 2015, we made a radical change to the Technoteach model, turning it into an accredited Level 3 Certificate in the Teaching of Computing. It became an 18-day, 120-hour course which required teachers to attend for one full day per fortnight, for which they needed to be released from school. The course consists of four modules (programming for teachers; teaching programming; data representation; and robotics); and there are primary and secondary versions of each module. As with all Technocamps activities, this course was provided completely free, including lunches and registration fees for the accreditation; however, schools would not be compensated for lost teacher time; the teachers would, in effect, have to be released for 10% of their time (one day per fortnight) to undertake the course.

In its first year, we managed to attract 13 teachers onto the programme of study starting in September 2015, and all 13 completed the course and graduated with their qualification in June 2016. In the second year, we attracted 18 teachers onto the programme of study starting in September 2016, and all 18 completed the course and graduated with their qualification in June 2017. Both of these cohorts were run at Swansea University, though some teachers travelled over an hour from all directions to attend.

When we first advertised this programme to schools, the immediate reaction was 'We cannot afford to do this!' However, as the quality and impact of the course is being felt, more and more schools are now saying 'We cannot afford not to do this!' In September 2017 a total of 43 teachers registered onto the course: one primary and one secondary cohort in Swansea; one secondary cohort in Bangor; and one 'transition' cohort in Newport. Cardiff has been a late adopter, perhaps because it has some quality computing provision due to being a large metropolis with many schools; but there are now large numbers of primary and secondary teachers in Cardiff (over 20 of each) pre-registered to start the Technoteach course in September 2018.

The Technoteach model

Technocamps has run the Technoteach operation on a budget of £12K per quarter supplied by the Welsh Government's National Science Academy. The bulk of this funding has gone towards the full-time salary costs of one delivery officer, with the remaining funds used for travel and subsistence, lunches for participants, and other incidental expenses.

At less than £50K per year, this has proven to be an extremely worthwhile investment which has been recognised by the Welsh Government through continued funding and promotion to other disciplines as a model well worth replicating. In terms of the teacher training, it amounts to less than £1K per teacher over the nine months of this year's course for 43 teachers. Furthermore, with four cohorts of teachers, the delivery officer is only delivering this training two days a week; during at least two other days each week this person is delivering workshops in primary schools as part of our Playground Computing programme of primary school engagement. They also have a great deal of support to offer the computer science department.

If other universities were minded to deliver such a programme of teacher training and associated schools outreach at a cost of £50K per year, we highlight the principles that are critical considerations.

An accredited qualification. In order to be meaningful, and to be considered worthwhile, the outcome must be a recognised and accredited qualification requiring a substantial investment of time and effort from the teacher undertaking the training. Anything less than a level 3 (A-level) qualification requiring little more than a teacher's (nonexistent) spare time attracts neither the buy-in from schools nor the necessary commitment from the teachers. It can be very time-consuming and costly to establish a suitable accredited programme of study from scratch, depending on which accrediting body provides the certification. Different universities across Wales are delivering the accredited Technoteach programme. For any other universities that are wary of going to the expense of establishing their own accredited programme, there is scope to deliver the Technocamps accredited programme with a minimum of preliminary quality assurance undertaken (the type of which universities are well aware and used to).

Long-term engagement. Teachers need time to assimilate the knowledge and skills which they develop through this training. With each full day of training, they will have learnt a great deal, and this learning will need to be practiced through a series of assigned exercises – and adapted for use in the classroom – during the fortnight leading up to the next training day. This is the only way for the programme of training to be effective.

Time off teaching. In conjunction with the above consideration, it is crucial that teachers are afforded the necessary time off from their classroom – one day per fortnight – in order to undertake this training. Modern-day teachers in the UK are under extreme pressures and cannot be expected to do this training on top of their full teaching commitments; attempts to do so inevitably lead to failure, as the demands placed on the teachers in the classroom far outweigh the demands required to succeed with the training. By releasing teachers effectively for 10% of their time, schools' headteachers provide a commitment to their teaching staff which is repaid through a dedication to succeed in the training and become effective at embedding and delivering the computing curriculum in the school.

University-based. University computer science departments are major stakeholders in this operation, as they strive to attract students from schools that have prepared them for studying the subject at university. Currently, A-level computing is not a prerequisite for studying computer science in university; in no other STEM subject (and very few non-STEM subjects) is this the case. By hosting these programmes of study, universities provide a level of gravitas which helps secure the necessary buy-in from schools and teachers. Furthermore, universities have the geographical reach which the NESTA report notes is sorely lacking from other organisations which might be otherwise placed to deliver this training. They also have the infrastructure and facilities (specifically, computer labs) necessary to run the training, for which it would be in their interests to provide free of charge.

Finally, it cannot be stressed enough the value of establishing and nurturing connections between university computer science departments and their regional school teachers in developing the pipeline of students – particularly female students – taking up the subject in secondary and higher education.

A teacher teaching the teachers. Although hosted by a university computer science department, the training cannot be left to a computer science academic in the department. It is crucial that the right person is hired to teach the teachers; and the right person is themselves a computer science teacher who is very much comfortable with the subject. They have to be able to speak to teachers with a full understanding of the teaching profession and of what is required of computer science teachers. The work on which the teachers are assessed must be directly relevant to the schemes of work with which teachers will need to be familiar.

This also has to be a full time job, as the teacher in the role has to be available to prepare and present the training and react proactively to developments throughout the week, unencumbered by the pressures of their own school teaching post. There will no doubt be a great deal of time in this person's schedule outside of teacher training; this time can be very usefully taken up by more informal school engagement activities, for example in helping to embed computing and digital competencies and in raising the profile of computing as a subject of choice amongst students.



ASFI Certificate in Computing for Teachers (QCF) Level 3



Free Computer Science CPD


 Swansea University
 Prifysgol Abertawe

www.itwales.com


 CARDIFF UNIVERSITY
 PRIFYSGOL CAERDYDD


 PRIFYSGOL BANGOR
 UNIVERSITY


 Cardiff Metropolitan University


 Prifysgol Metropolitan
 Caerdydd


 Ariennir yn Rhannol gan
 Lywodraeth Cymru
 Part Funded by
 Welsh Government


 PRIFYSGOL ABERYSTWYTH
 UNIVERSITY


 PRIFYSGOL
 glyndŵr
 UNIVERSITY


 University of
 South Wales
 Prifysgol De Cymru

References

- Bell, B., & Gilbert, J. (1996). *Teacher development : A model from science education*. London: Falmer Press.
- CUREE. (2014). *The challenge of maths and english teaching in the further education and skills sector in England*. Centre for the Use of Research and Evidence in Education.
- Darling-Hammond, L. (2017). Teacher education around the world: What can we learn from international practice? *European Journal of Teacher Education*, 40(3), 291-309. doi:10.1080/02619768.2017.1315399
- Education Workforce Council for Wales (2017). *Statistics Digest*. Available at www.ewc.wales/site/index.php/en/documents/research-and-statistics/annual-statistics-digest/762-ewc-statistics-digest-2017. [Accessed 13 April 2018]
- Henderson, C., Beach, A., & Finkelstein, N. (2011). Facilitating change in undergraduate STEM instructional practices: An analytic review of the literature. *Journal of Research in Science Teaching*, 48(8), 952-984. doi:10.1002/tea.20439
- Park, M., & Sung, Y. (2013). Teachers' perceptions of the recent curriculum reforms and their implementation: What can we learn from the case of korean elementary teachers? *Asia Pacific Journal of Education*, 33(1), 15-33. doi:10.1080/02188791.2012.756391
- Quinlan, Oliver (2015). *Young Digital Makers: Surveying attitudes and opportunities for digital creativity across the UK*. NESTA. Available at: www.nesta.org.uk/sites/default/files/young-digital-makers-march-2015.pdf. [Accessed: 11 April 2018]
- Sentance, S., Humphreys, S., & Dorling, M. (2014). The network of teaching excellence in computer science and master teachers. Paper presented at the *Proceedings of the 9th Workshop in Primary and Secondary Computing Education*, Berlin, Germany. 80-88. doi:10.1145/2670757.2670789
- Wei, R. C., Darling-Hammond, L., & Adamson, F. (2010). *Professional development in the united states: Trends and challenges*. Dallas, Texas, USA: National Staff Development Council.

