Encouraging Young Engineers (EYE)
Outreach workshops designed to encourage young people to take a look at engineering

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Abstract
This project has supported the development of outreach workshops for delivery by university student volunteers in local schools with the aim of engaging young people from under-represented groups in engineering. The workshops explore how different engineering disciplines contribute to the design and development of hi-tech products, specifically focusing on the interaction between software and hardware. The workshops were developed in collaboration with WMG (formerly Warwick Manufacturing Group), Local Education Authority representatives, BCS (the Chartered Institute for IT, formerly the British Computer Society) colleagues and local teachers. One has already been delivered at a local school and at several teacher conferences in 2011 with the assistance of student volunteers from Warwick University for the pilot studies. The intention is for delivery of the workshop to be student-led and to proceed with delivery of the others to local schools through the university volunteer scheme (Warwick Volunteers) from 2012 onwards.

Keywords: outreach, hardware, software, undergraduate volunteers

Background
There is an opportunity to take advantage of young people in Key Stage 3’s existing interest in and fascination with aspects of technology before they have made subject choices for GCSE, by which time barriers may already be put in the way of a subsequent engineering career by their choice of subjects. Most young people use technology every day but rarely consider the underlying principles because the products are designed to be easy to use and hide the underpinning technologies.

Warwick Volunteers provides opportunities for students and staff at the university to volunteer in a variety of roles within the local community. The ‘Technology Volunteers’ scheme operates through Warwick Volunteers (who provide CRB clearance and safeguarding training). The ‘Technology Volunteers’ scheme has run software development workshops in local schools for four years. In recent years the scheme has attracted almost equal numbers of male and female student volunteers from a variety of backgrounds, giving a positive mixture of role models. Student volunteers are enthusiastic about their subject and able to engage with young people. Creating new workshop resources that the volunteers can use in schools increases the range of workshops they can run and enhances their skills.

Through existing voluntary activities there is a well-established informal collaborative network with good links already in place between representatives of the Coventry Local Education Authority (LEA), local schools and universities, the Coventry branch of the British Computer Society and the IET. The advantages of a local collaborative approach to this aspect of outreach work are described in detail by Glendinning and Low (2010).

WMG is an academic department of the University of Warwick. It carries out applied and practical research under three main themes: Materials and Manufacturing; Digital Technologies; and Operations and Business Management. Postgraduate education programmes, based at WMG and centres overseas, include full-time MScs and research degrees (PhD and EngD) as well as part-time professional and executive programmes for managers in technology-led companies.
Rationale

Highly sophisticated devices, designed to be easy to manipulate without an understanding of how they work, are embedded in our society and, as a consequence, young people from all groups and backgrounds are immersed in this technology. This immersion provides an opportunity for us to encourage young people to reflect on how such devices operate and in what possible ways they could develop in the future. By its nature, the programme crosses engineering boundaries, with potential for different focuses for a variety of workshops.

Existing engineering workshops often engage pupils by encouraging them to construct mechanical apparatus but do not take advantage of the ways in which disparate branches of engineering converge to produce a modern hi-tech product.

The immediate outcome of this project has been to extend the range of workshops offered to local schools, delivered by university students through the ‘Technology Volunteers’ scheme (go.warwick.ac.uk/techvolunteers). Existing workshops use Scratch (MIT Media Lab, 2012), a freely available programming language created by MIT, as a software development tool. The resources developed in this programme enable us to develop activities which explore aspects of systems and control engineering through the use of Scratch sensor boards.

Equipment and resources purchased for the pilot will have continuing use in the ‘Technology Volunteer’ workshops and in other outreach activities undertaken through the university.

The long term objective of the workshops is to raise the profile of engineering as a possible career by engaging school pupils in engineering problems with a discussion that sets them in the context of the professional engineering discipline. We hope that some of these pupils will, as a consequence of the workshop, go on to study engineering.

A side benefit of this project is that the student volunteers are encouraged to become STEM Ambassadors through the ‘Technology Volunteers’ scheme. The skills and confidence of the volunteers who take part in this programme are enhanced, leading to them become more effective STEM Ambassadors.

To summarise the aims of this project:

- Raise awareness and interest in engineering profession and careers
- Work with young people from groups that are under-represented in higher education
- Encourage female participation through the use of female role models
- Creation of resources for use by Technology Volunteers and STEM Ambassadors
- Broaden skills of current volunteers.

The approach

Young people carry sophisticated mobile phones around that have many sensory capabilities, so giving them an insight into how the hardware and software interacts and the use of sensors in these devices became the focus for this project. The approach taken by this project was to focus on creating a short one-hour workshop for pupils in Key stage 3 that gave an insight into how sensors were used in mobile phones. This covered aspects of the Design and Technology and ICT school curriculum.

The ideal scenario for a workshop is to deliver it to whole classes in local schools where few pupils aspire to higher education or have significant awareness of engineering careers, using student volunteers as accessible role models. Working with a whole class ensures that everyone is introduced to the concepts in the workshop and that groups of people aren’t able to opt out of it because they believe it is “not interesting”.

The intention is to make the delivery of the workshops developed through this project sustainable by including them in the menu of activities offered to schools through the ‘Technology Volunteers’ scheme. The expectation was that students who participated in the pilot would help to mentor the next generation of volunteers in these new workshops, thereby forming a self-sustaining group of practitioners.
Collaborators on this project were colleagues in WMG, representatives of LEAs, members of local professional bodies (BCS and IET) and the local STEMNET co-ordinator. The LEA advisors are particularly valuable in providing good contacts with schools that could benefit from the scheme. Other useful sources of information were the London Engineering Project (LEP) case studies, which provided useful guidelines on the format of workshops (London Engineering Project, 2012).

The preliminary stage of the project was to identify and agree specific topics that would interest young people. Input from the local collaborators was particularly helpful at this stage, both in ensuring a clear focus and in considering what other activities could spin off from an initial workshop.

The plan was that workshops should act as springboards, rather than closed activities, and also be flexible enough to be amenable to extension in a variety of ways. It was also important that new workshops were designed to build on the existing skills of the student volunteers and that the apparatus involved supported open-ended activities. These considerations were taken into account when purchasing equipment to support the workshops.

The development stage consisted of the exploration of the ideas for the workshops in a semi-structured way with the student volunteers in order to refine our ideas as to what would work well and to consider the approach to be taken in presenting the workshops to school pupils to maximise their engagement. The final workshop materials take into account pupils' different experience levels with Scratch, their keen interest in creating games, their need to see something working at an early stage in the workshop and the inclusion of sound (if the school computer lab supports it).

In the pilot stage, I led workshop delivery with the assistance of student volunteers, the aim being that subsequent workshops would be led by the student volunteers with the involvement of such WMG staff, BCS volunteers and STEM Ambassadors as wished to participate.

**Evaluation**

There are two sets of feedback on the workshops: informal feedback from teachers and formal feedback from school pupils to whom the workshops were delivered.

Feedback was obtained informally from teachers after the workshop was delivered to them at the local ICT&L teachers’ conference (Low, 2011a) and at the national conference, CAS 2011 (Low, 2011b). This was generally positive, but some concerns were expressed about whether school pupils would have the ability to interface effectively with the graphical block programming environment used in the workshop. The volunteers already had experience of using the programming environment with primary school children for several years and always work as part of a team, having recognised the value of additional tutorial support to overcome any initial difficulties some pupils may have.

Formal feedback was also obtained on the workshop delivery from a year 10 ICT class (whole class - pupils not selected) and from a self-selected year 9 group. Due to timetabling difficulties it was only possible to run the workshop with one KS3 group (year 9) and a year 10 group. Based on 17 responses out of 19 pupils in year 10 and 13 responses out of 17 from year 9, the experience was generally found to be positive (see Figure 1).
It is worth stressing that the year 10 group feedback shows a positive experience similar to that of the self-selected year 9 group, even though the year 9 group consisted entirely of male pupils who opted into the session. Although this is clearly a small amount of data, it suggests a significant disparity between the expectation and the actual experience of girls in engineering and computing which deserves further investigation.

Further refinements to the workshop materials will be made to try to improve pupil engagement and enjoyment of the activities and to give guidance on further resources to ensure pupils can continue their personal development after the workshop.

Discussion, summary

Overall, this project has supported the development and presentation of successful workshops to engage school pupils in aspects of engineering and computing. A number of different resources have been produced. One workshop tutorial has been published online and circulated at ICT&L 2011 (Low, 2011a) and CAS 2011 (Low, 2011b), while others are currently in production and awaiting wider distribution.

In the preliminary stage of the project, the hardware required to support the workshops (Scratch sensor boards) was identified and purchased. Scratch (MIT Media Lab, 2012) is a freely available programming language produced by MIT which provides an excellent introduction to software development and control. The volunteers already have experience of Scratch and its use for introducing software development to school pupils (Low, 2010). The sensor boards cost under £40 each and a set of 20 was purchased to support a typical school computer lab. The boards can be connected to four additional sensors, giving plenty of scope for further workshops.

In the development stage, we came to the conclusion that a particularly engaging activity would be to give the pupils a simple keyboard controlled game and have them adapt it to use the sensor board as a game controller. This was the activity we developed as a pilot workshop. Some other possibilities arose, involving the inclusion of additional sensors. Rather than purchasing ‘off the shelf’ solutions, the idea was to get young people to build them. For example, a simple tilt sensor can be built using a plastic bottle, two pins and salty water. Workshops based on these other ideas are currently in development.

The original intention was that students involved in the school pilot workshops would mentor and train the 2011/12 cohort of student volunteers. In fact, this didn’t quite work out because the...
2010/11 student volunteers were offered industry placements and did not participate in the pilots and the students that participated in the summer pilots are no longer at Warwick.

At the start of the academic year in October 2011 it was straightforward to train this years’ cohort of volunteers in the new workshop as returning volunteers already had experience with the programming environment – hence we have reached the same level of sustainability as planned, albeit by a slightly different route. In term 1, new student volunteers undergo CRB clearance and safeguarding training, with returning students delivering the training in the programming environment. This fits with the aim of Warwick Volunteers to encourage and support student-led projects. In term 2 they will be delivering the extended range of workshops in local schools.

A significant loss to this project was the closure of the Coventry & Warwickshire STEMNET contract holder in March 2011. In the interim I established contact with the West Midlands region STEMNET, however in October a new Coventry area contract holder was appointed and contact has now been made with them.

The equipment purchased has also supported other outreach activities, including the Imagineering@Airbase Fair 2011 and a public workshop at the BBC Coventry and Warwickshire Open Centre.

In conclusion we have

- developed workshops to engage KS3 school pupils in engineering and computing
- formed a collection of equipment and resources that can also be used to support additional outreach activities
- gathered some interesting evidence on contract between the perception and actual experience of girls regarding engineering.

Further development

There is still a great deal of scope for development of homemade sensors and their application in conjunction with the Scratch sensor board, including the tilt sensor mentioned above and making links with the science curriculum.

There is also the exciting possibility of bringing these ideas to the general public rather than concentrating purely on children of school age. We are organising a family workshop during the February half-term holiday, hosted by BBC Coventry and Warwickshire Open Centre. We have also been invited to run a sensor workshop for the Coventry branch of BCS in an evening meeting aimed at interested adults. We hope this will provide the opportunity for synergistic interactions with people from a variety of backgrounds.

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References


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