Why Bother Taking University Led Chemistry Outreach into Primary Schools? Bristol ChemLabS Experience

Tim G Harrison*
Bristol ChemLabS
School Teacher Fellow
Dudley E Shallcross
Bristol ChemLabS
Outreach Director

School of Chemistry
Bristol University
BS8 1TS

***t.g.harrison@bristol.ac.uk**

Abstract
The School of Chemistry, University of Bristol is taking postgraduate Chemists and circuses of practical chemistry experiments into primary schools to enthuse, excite and educate tomorrows chemical scientists. With over twenty workshop visits undertaken in 15 months we share our recent experiences.

In 2005 the School of Chemistry at the University of Bristol became a HEFCE Centre for Excellence in Teaching and Learning (CETL), the only one dedicated purely to Chemistry. The CETL project, known as Bristol ChemLabS (Bristol Chemistry Laboratory Sciences), is focused on the development of practical work for undergraduates. A second strand of the project is to expand its Outreach activities with a number of groups. Apart from the usual targets for such activities, i.e. those in the wider community and secondary school students, Bristol ChemLabS also decided to explore Chemistry Outreach events with UK primary aged pupils (4-11 years of age).

Local regulations do not allow primary aged pupils to use the laboratories at Bristol University's School of Chemistry. To engage with this cohort therefore requires the School of Chemistry to move out of the university and into the primary schools themselves.

Taking practical chemistry into primary schools is also the most time demanding and resource intensive engagement activity. A typical day in a primary school consists of a full school assembly and two workshops each comprising a circus of experiments.

Three modes of engagement have been tried. The first mode was an on-line science quiz that was trialled with 1200 local pupils registering in 2006. The quiz, using questions from the Key Stage 2 (KS2) Science curriculum, was hosted by the university's existing computer resources. Pupils were presented with certificates at gold, silver and bronze level according to their scores. This approach is running again in 2007. Second, Chem@rt is a gallery of around a dozen images taken from recent chemical research at Bristol and is sent out to schools to act as stimuli for written work (poems and prose) by pupils of all primary ages. The class teachers nominate winners per class per image and all students who take part receive certificates with the winners receiving gold awards. Between 5000 and 6000 pupils took part in the southwest of England in Chem@rt006. The follow on, Chem@rt007, has already been launched. The main thrust of our work, and the subject of this article, is the taking of practical chemistry exercises into schools.

Taking practical chemistry into primary schools is also the most time demanding and resource intensive engagement activity. A typical day in a primary school consists of a full school assembly and two workshops each comprising a circus of experiments.

The assembly is generally given to the entire primary school population which can be an audience ranging from 100 to 400 pupils aged between 4 and 11 years of age. The demonstration assembly is normally about the gases in the air which acts as a good excuse to use liquid nitrogen, dry ice, perform the elephant's toothpaste experiment, to set fire to a few materials including hydrogen balloons and compare them to the helium filled versions. Care is taken to relate the experiments demonstrated to the science curriculum and, more importantly, the terminology used at KS2.

The practical workshops last a little over 2 hours each so that two classes per day can experience them. The pupils are usually in Year 5 and 6 although in some small rural schools this can be a mixed group of pupils from Years 4 to 6. A normal primary classroom or a school hall is temporarily turned into a lab for the day. Three large groups of tables each house an experiment. All pupils, and accompanying teachers and teaching assistants, are fitted out with appropriately sized lab coats safety glasses and gloves. Each experiment is supervised/demonstrated by either a postgraduate Chemist or the School Teacher Fellow.

The primary school usually lets Bristol ChemLabS choose which experiments to be used. The small suite of experiments available is designed to reinforce measurement, investigatory and cooperation skills. Typical experiments involve the pupils

Figure 1: Pupils reinforce measuring, observational and team work skills during the circus of experiments

working in pairs and correctly using measuring cylinders and stopwatches. No time, other than that needed for recording measurements is spent in writing and little time is spent in reading of worksheets. Instead instructions are given orally by the postgraduates working with the groups of 12 pupils. Also it is felt that time spent in discussion of results and observations with young practising chemists are more worthwhile than written observations. Any follow-up written work can be undertaken by the class teacher in a later session.

What is the circus of experiments that make up a workshop visit to primary schools? Examples of experiments include adaptations of the iodine clock experiment, work on polymers, the rate of reaction between dilute acid and magnesium, thermochromic pigments and the chemistry of toothpaste. In the iodine clock experiment the pupils are shown the reaction and are asked to investigate the volume of water needed to make the clock change colour at a target time such as 60 seconds. Discussion of safety, fair testing, accuracy in measurement, team work and reproducible results are thrown up by this experiment as well as the acid magnesium investigation. The pupils like the element of competition and some simple prizes are given to the pairs that are the closest to the target when the 'judge' does the timing! In the polymers workshop pupils investigate the degree of cross linking of PVA with borax in making slime, the source of PVA white glue versus the 'pure' PVA source and the thermoplastic properties of the polymer available as 'polymorph'. The polymorph experiment also lends itself to a brief model making competition. The toothpaste workshop starts with a mind mapping exercise on what makes good toothpaste. Several small experiments that compare pH, frothiness and stickiness of several commercial toothpastes are then undertaken.

In the thermochromic workshop a discussion of paint properties is followed by the making of thermochromic paint by mixing appropriate pigments with acrylic paint in very small quantities The temperature at which the paints change colour is then investigated by painting plastic cups and adding hot and cold water until the temperature of the colour transition is discovered. For specific examples of outreach visits in primary schools please see Bristol ChemLabS outreach web site: www.chemlabs.bris.ac.uk/outreach

All the postgraduate Chemists that are involved with these engagement activities have been trained through the Science and Engineering Ambassador Scheme (SEAS). The training involves discussion of the responsibilities of the postgraduates and of the class teacher during outreach visits, what to do if… scenarios, a session on the absolute need to be able to communicate at an appropriate level with the target audience and appropriate professionalism whilst in schools, e.g. punctuality. Lastly the PGs will also have a Criminal Records Bureau (CRB) check completed, a necessary requisite to work with school age pupils in schools. The SEAS are also insured

Figure2: A young chemist displays her freshly made PVA slime

as part of the scheme. Over 100 postgraduate chemists at Bristol have been through this training in the last 18 months. The benefits to these postgraduates of such endeavours are the subject of a future publication, but these will include the

training they receive in public engagement and further communication skills they acquire. All postgraduates involved have reported that the interaction was a positive one and several have reported very positive outcomes.

Where does the finance come from to support the visits? Outreach to primary schools need not be a charitable act. To take 2 or 3 experienced postgraduate chemists into a school with £4k worth of equipment does cost a fair sum of money. Travelling expenses, accommodation, technician time, disposable costs and laundry are just some of the costs involved that need to be met. Bristol ChemLabS does ask schools to contribute to these costs. Schools have access to a variety of funding sources, from Gifted and Talented funding and special projects funds such as those put aside for science weeks. Other funding sources include the local branches of the Royal Society of Chemistry (RSC). Local specialist science colleges have also funded workshops for their family of primary schools. In our experience the availability of funds to support good quality science outreach activities for primary schools does not appear to be a problem.

How do we know whether this sort of activity will lead to an increase in Chemistry uptake at A-Level or degree and does that matter? Tracking pupils from 10 to 19 years of age would be expensive and time consuming. Naturally formal and informal feedback from primary headteachers, primary

Figure 3: School teacher Fellow Tim Harrison demonstrates liquid nitrogen as part of the whole school assembly talk on 'gases in the air'

science coordinators (most of whom are not science specialists let alone chemists), class teachers, pupils, and the postgraduate chemists themselves is sought, reviewed and acted upon. We have also had experience of feedback from parents of pupils that have experienced chemistry workshops. Gut instinct and ephemeral evidence is that such activity must be a contributing factor to selection of A-Levels. When asked what prompted her into studying chemistry one Bristol

Figure 4: The pleasure of doing practical chemistry in a primary school is evident!

postgraduate Chemist related a story about a visit by a scientist to her own primary school. Even if not, such activity is worthwhile in its own right even if it simply supports colleagues in science education in the primaries.

One primary teacher recently reported that when a parent at Parents' evening asked whether her son was still intending to be a professional footballer the boy replied "No. I am going to be a research scientist". Whether we have lost a future David Beckham or gained a Chemistry Nobel Laureate would be impossible to tell.

Summary
Primary school outreach need not be financially draining to a chemistry department, schools can pay for activities and there are other sources of funding available. Primary science has virtually no Chemistry input at all, dominated by Physics and Biology (Botany) with some meteorology. Primary school pupils relish the opportunity to carry out real Chemistry investigations and all feedback has been extremely positive. Primary science teachers are often non scientists and find the workshops we run as exciting and engaging as the pupils and welcome the contact with practising scientist. It is too early to tell whether the Bristol ChemLabS primary outreach program will have a long term impact on the pupils it has engaged, however the immediate benefits in terms of feedback suggest it will. The SEAS training scheme provides an excellent platform for postgraduates to take part in this activity and they too reap significant benefits in terms of personal development by taking part in this activity, as well as being excellent role models to these young people.

In our experience the availability of funds to support good quality science outreach activities for primary schools does not appear to be a problem.

Appendix
Quotes from thank you letters written by pupils at Moss Hall Junior School, Finchley, London

I had a great time when you came and it was extremely fascinating. Since then I have learnt a lot and now want to study further, not just because of the experiments which were fantastic –but Chemistry is an exceedingly interesting subject. (Excerpt from newsletter to primary parents)

I have never done anything like that and I really enjoyed doing it. I also learnt a lot of knew words…. It was the best science lesson I ever had! Rhianna

The workshop was one of the most interesting events ever at our school. So was the assembly. Now I am really looking forward to doing chemistry at secondary school. I am even going to do it at GCSE when I am older! I am really interested now in scientific things. Toby

I hope you come back and visit us again with more interesting experiments.
Charlotte

My dad says when I am older I will go to Bristol University. Finbar

I can't wait to learn about chemistry at secondary school. Madeleine

I liked the bit when you froze the banana…..I never knew science could be that fun. Ruby

I really liked the workshop tasks because we got to wear the safety goggles, the lab coats and rubber gloves. It made me feel like a true scientist. James

It was fascinating to learn about gases and chemicals. I told my family all about it. Julia

I had a great time and I might learn chemistry when I am older. I would like go to your university and learn more chemistry with you. Nadav

Thank you for your assembly. It was the most exciting assembly I have ever had… I thought it might be good if I (were to) be a scientist. It was my first time using (a) chemical. Tatsuma

My favourite bit was blowing up the balloons… when there was a sheet of flame. I thought it was the best school day of my life. Taishi

You have really encouraged me to become a scientist like you. Thank you very much. Daici

It was very fascinating to learn the stuff you do especially that we're in junior school and most people only get to do it in secondary school. Julia