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FINAL YEAR SCHOOL PROJECTS: THE BRISTOL CHEMLABS USE OF THE UNDERGRADUATE AMBASSADOR SCHEME

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Abstract: As part of the final year of their undergraduate degree programmes, some chemistry students at the University of Bristol spend time in local primary or secondary schools working on chemistry or chemical education problems. All partners gain from this programme. The students develop many of the transferable skills required by employers in all sectors. The scheme also provides them with the chance to gain some experience of working in schools, at the same time as acquiring credit as part of their degree programme. Many of the participating students go on to postgraduate teacher training courses and become committed and effective teachers. The schools benefit from having young enthusiastic science role models, assistance in the classroom and an opportunity to develop and run new projects. The scheme also helps the university department develop better links with neighbouring schools.

Zusammenfassung: Als Teil in des abschließenden Jahr haben in meistens Universitätsprogramme, einige Chemiekursteilnehmer an der Universität von Bristol, haben Zeit verbracht in den lokalen Primär- oder Weiterbildenden Schulen , die mit Chemie- oder Chemikalien- Ausbildungsprogramme arbeiten. Alle Partner sind gewonnen von diesem Programm. Die Kursteilnehmer präsentieren viele der übertragbaren Fähigkeiten, die von den Arbeitgebern in allen Sektoren benötigt werden. Der Entwurf versieht sich auch mit der Wahrscheinlichkeit, etwas Erfahrung des Arbeiter in den Schulen zu gewinnen, im Praktikum, als Teil ihres Universitätsprogramms zu erwerben. Viele der Kursteilnehmer gehen zu den fortgeschrittenen Ausbildung oder andere Lehrerkursen um zu einen wirkungsvoller Lehrer zu werden. Die Schulen profitieren vom jungen enthusiastischen Wissenschaften, es spielt aber auch eine wichtige Rolle im Klassenzimmer und ermöglicht die Gelegenheit neue Projekte zu entwickeln. Der Entwurf hilft auch in dem Fachbereich bessere Verbindungen mit benachbarten Schulen zu entwickeln.

Key words: Undergraduate Ambassador Scheme, Chemistry, School Teacher Fellow, Outreach

1. Introduction

The UAS (Undergraduate Ambassador Scheme) [1, 2] was set up in 2002 as a response to both the shortage in the UK of science, technology and mathematics subject teachers and the fall in applications to universities in these key areas [*ibid*]. Central to the scheme is the ideal that undergraduates, schools, and universities should all benefit from their involvement. The UAS originated in Mathematics and Physics departments with 28 undergraduates from four university departments participating in 2002. In January 2009, the number of students has risen, so that the scheme now encompasses students from 123 departments within 44 British and Irish universities. The subject areas now include Biology, Computer Sciences, Chemistry, Electronics, Engineering, Environmental Sciences, Food Sciences, Geography, Geology, Modern Languages, Music, Oceanography, Plant Sciences and Sports Sciences [3]. Amongst the current participants are 16 UK Chemistry departments.

UAS is operated by Undergraduate Ambassadors Limited, an independent not-for-profit organisation. This scheme is endorsed by the Royal Society of Chemistry, Institute of Physics, London Mathematical Society, the Institution of Structural Engineers, The Royal Society, the Institute of

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Materials, Minerals and Mining and the Institute of Marine Engineering amongst others, the professional bodies for many of these subjects

The School of Chemistry at the University of Bristol has been involved in this scheme for three years. Annually, groups of 5–7 final-year students have opted and been selected for the 'schools project' in place of their traditional laboratory-based research project. The majority have come from the University's 3-year BSc Chemistry programme. This programme is traditionally taken by students who have a keen interest in science and who enjoy chemistry, but who do not intend to follow a career in laboratory-based research. Students intending to pursue a career in research would usually instead follow one of the University's 4-integrated MSci programmes and be expected to carry out a traditional laboratory-based project in their final year.

Apart from the academic credit that any final-year student must have, the schools project is ideal for those considering a career in teaching. Students have the chance to see what teaching is like from a teacher's perspective rather than the rose-coloured glasses vision inherited from their time as a pupil. The time spent in schools is also useful in supporting applications for possible teacher training.

The schools project is not considered an easy option. When working within a research group there are, in addition to the project leader, postgraduates and postdoctoral research assistants to consult; this is not the case with outreach. Students have to be more self reliant and be able to interact with a range of people, e.g. teachers and school students, and enter an environment that may be quite alien. Students in the School of Chemistry at Bristol do, however, have the advantage of working with a School Teacher Fellow [4, 5]. Fortnightly group meetings between group members allow discussion of experiences and self support. Other meetings are more targeted such as the use of electronic voting systems, poster design and how to carry out the more spectacular lecture demonstrations including the use of liquid nitrogen, dry ice and minor explosions. Other meetings would be to rehearse and self evaluate presentations.

Before the applications for the final year projects are made prospective applicants are invited to a meeting to explain the way the 'schools project' operates. Throughout the year there is a large poster [6] describing the Undergraduate Ambassador Scheme prominently displayed outside the second-year teaching laboratory which uses information from UAS and gives a link to the department's own outreach web site pages for UAS [7]. The web pages not only link to the national scheme but also give examples of previous projects, an interview with a previous student and an example of a reflective practice diary [8] but with specific references to school students and teachers removed.

The projects are very popular amongst the student cohort. Each year, more students ask to be allocated a schools-based project than there are places available. Selection is then made on a range of factors, including academic achievement to date and their motivation to engage fully with the aims of the project.

All traditional final-year projects allow undergraduates to develop a range of skills. These will typically include technical skills such as being able to use of various pieces of apparatus, but will also include transferable skills such as problem solving, communication skills, time management and organisation. The schools project offers all of these elements too. In addition, however, students develop numerous other transferable skills including reflection, educational research and lesson planning, presentation and organisational skills. They become proficient both at working independently and as part of wider team. In many traditional research projects students build on previous work performed within the group in which they are working. In contrast, the schools projects undertaken are usually highly original and do not rely on, or benefit from, previous work. The schools projects also help students to improve their subject-specific knowledge and understanding. Teaching others helps to their own understanding of aspects of chemistry at the same time as increasing the knowledge of others.

The schools project often gives students more flexibility in designing their project. They get the chance to implement imaginative ideas because they are not hampered by the restrictions of operating within a laboratory environment where the availability of equipment and resources, and the need to work safely.

The schools projects are assessed in exactly the same way as the traditional research projects, using the same criteria and mark sheets. Important elements of a traditional project translate directly across to the schools project. The requirement to keep a laboratory notebook is, for example, replaced simply by the need to keep a reflective diary.

What is involved?

The project is made up of several parts. The initial part prepares the chemistry students for going into schools, whether primary or secondary, to work with teachers and school students. The second stage places the students in local schools for a period of classroom observation. The third stage involves working on the project and the final stage involves the preparation of the formally assessed components.

Naturally, before any student goes into a school he or she needs to be prepared. In the initial stage, seminars are given on whole-school issues, such as the rights and responsibilities of the students and teachers, appropriate behaviours, the importance of the correct levels of communication between UAS and students and UAS with teachers, the structure of the education system (not all UAS students may have been through the UK school system), resources available, how to set about lesson observing and the requirements of the project. Academic staff from the University of Bristol's Graduate School of Education and from other departments participating in the UAS are involved as well as staff from an outside agency that provide training through the Science and Engineering Ambassadors Scheme (the subject of a future paper). As part of this training the students go through a Criminal Records Bureau (CRB) check. The CRB check is required for all people working with school-aged students in the UK and involves a police check on the individuals going back several years.

The period of classroom observation is coupled with some team teaching of chemistry or science in the latter stages. The UAS students are encouraged to observe a variety of science teachers and teachers of other, non-practical subjects such as modern languages. Where possible, students are also asked to do a pupil and a teacher pursuit and to see different abilities of students taught. This is so that different teaching styles, lesson structures, levels of demand, behaviour and school systems are investigated. In primary school, this is a little more difficult as these schools tend to have small numbers of classes. During this time students keep a reflective practice diary to note what they have seen, done and learnt and also to note questions to which they need to find answers. The reflective practice diary takes the place of a laboratory notebook and is part of the examinable component.

The total period for visiting with the schools is during the first two undergraduate terms. Whole-day school visits are seldom possible due to the demands of the lecture and seminar timetables. In practice two visits per week are made with an equal time spent in preparation and research outside of the school. In this time the undergraduates may be supervised in helping to run after-school science clubs, taking revision classes, or engaged in the promotion of chemistry events.

During the second term the undergraduate devises a project on the basis of discussion with the school, the department's School Teacher Fellow and their own interests. The project must be useful to the host school or Bristol ChemLabS as a minimum case. The projects have ranged widely from surveys of teachers opinions on changes to the national curriculum, preparation of chemistry practical work for primary pupils at home, for gifted and talented or for classroom activity, an investigation of whether there was a link between speaking multiple languages and being good at science in primary schools, and developing lessons for the teaching of spectroscopy in schools (including the use of a mobile infrared spectrometer). A teaching package for all the new components of new pre-university chemistry courses on the 'leading edge chemistry' components was considered of sufficiently high standard to be published by the Royal Society of Chemistry on their web site [9] The package not only explains the new material but also gave lesson plans for its delivery.

A third part of the examinable component is the presentation that has to be given in front of the rest of the group, the academic examiners and invited guests. This occurs at the start of the third term. Each presentation is between 15 and 20 minutes long including a five minute session of fielding questions from the floor. The presentation may be on any aspect of their school experience or their project. The students are scored on their presentation skills: oral work, visual presentation and ability to field

questions. With the last intake it was commented that these students gave uniformly better presentations in terms of confidence, understanding of their work, entertainment and skilful use of packages such as PowerPoint than those of students taking conventional laboratory-based projects. Indeed the students in the audience were so taken with aspects of the presentations that the questioning session often had to be halted with several questions left unasked. Examples of presentations [10] may be found at Bristol ChemLabS Outreach web pages.

Advantages for participating schools

There are many reasons why schools look forward to hosting, and often request, schools project students. Teachers get an extra pair of hands in some of their lessons. This allows them to implement small projects for which they would otherwise not have time. Students may take small groups, deliver sections of the lesson such as a practical demonstration or acts as judges for competitions! The teachers also benefit from working with someone who is able to update their knowledge on aspects of recent developments in chemistry. Enthusiastic undergraduates can be role models for the students with whom they are engaged. Some of the projects are in collaboration with the teachers or are specifically at the request of the teachers. One independent 4–18 school whose co-site primary school wanted to use a UAS student to look at the progression of subject knowledge across the primary to secondary divide. Furthermore, the undergraduate chemists have access to instrumentation and chemicals not normally available in schools. Recent examples include the use of the department's portable (14 kg) infrared spectrometer as well as lecture demonstrations using liquid nitrogen, hydrogen filled balloons and dry ice. The UAS students also have access to materials that some schools may not have considered using such as smart materials, fuel cells, Grätzel cells and carbon dioxide meters and that although are available to schools the might not know about. Some school groups have been brought into the department for tours and talks. Unlike the supervision of trainee teachers the paperwork involved is minimal and consists of half a page of report. The requirements for the UAS scheme are rather less demanding than for a student undergoing formal teacher training as part of either an undergraduate or postgraduate qualification; schools may therefore use a UAS student very flexibly. After all the students are not there to learn to become teachers!

Advantages for the School of Chemistry

(a) The UAS forms an important part of the department's wider programme of outreach [11, 12] and public engagement. As one of the UK's largest and most prestigious chemistry departments, the School of Chemistry takes seriously its responsibility to promote chemistry and to help to increase the uptake by students of chemistry degree programmes both in Bristol and elsewhere.

(b) In an over-subscribed chemistry department, the number of research laboratory projects, even with 250 postgraduate chemists, is limited. The ability to offer genuine and meaningful projects that do not require laboratory space is helpful.

(c) It is important to have a wide choice of projects available in order to meet the diverse requirements and aspirations of all students; several students have already made up their mind not to pursue a research-based career.

What are the advantages for the undergraduates?

Apart from the academic credit that any final-year student must have, the schools project is ideal for those considering a career in teaching. Students have the chance to see what teaching is like from a teacher's perspective rather than the rose-coloured glasses vision from a pupil's position. The time spent in schools is also useful in supporting applications for possible teacher training.

> *"Doing this project made a lot of sense for me, as I knew I wasn't after a career in chemical research and teaching was, and still is, what I want to do. Had I not done this project it may have been difficult to get teaching experience this year as well as spending hours in a lab. As the project was so open ended a lot of initiative and creativity was needed but this was an enjoyable challenge. Going back to basics and seeing science from the perspective of a primary*

school pupil helped me develop a fresh approach to science."
Jane Boyes (UAS, 2007)

An interview with a UAS Student (July 2008)

Q. What did you get out of the UAS schools project?

A lot! Not only did I start to learn how to teach, and develop extremely useful skills for later life (communication, leadership, presentation...), but you get to contribute to pupils' education, be a role model, and also develop research skills in the process. I therefore learned a lot about the topics I was researching.

Q. What do you think the schools got out of the project?

I think they had a teacher's aide, someone to give the pupils more attention in class, and also provide them with knowledge they might not have learnt without a chemistry student there. The lessons were more productive and more content was covered as two teachers could share the workload and provide more attention to pupils. In addition, 'magic shows' were performed, using university equipment which schools would not normally have access to. I also very much hope they enjoyed having me there, and also learnt something from me, as I learned a great deal from them.

Q. What do you think the school students got out of the project?

I think they learned some content that they would not normally have learned in their course. They also got to observe demonstrations they would not normally see in school. They received extra attention, and also had the opportunity to hear explanations taught in a different style, hopefully boosting their understanding and enjoyment. They also discovered more about studying chemistry at university, which they had a lot of questions about.

Q. What did you enjoy the most?

Teaching the pupils, especially one on one and performing the chemistry 'magic show'. [Note the authors do not like the term 'magic show' but prefer the term 'lecture demonstration'].

Q. What did you enjoy the least?

Telling off badly behaved pupils!

Q. What would you do differently if you had to do it all over again?

Try to discover the exact nature and content of my project before entering the school so I can 'hit the ground running', although this is difficult as you discover needs and come up with ideas through teaching and being in a school.

Q. Will you apply for teacher training?

Yes I will, I have already sorted a job for the next year, but will apply during the year, some of my friends from home are starting this September (as they graduated last year) so I am looking forward to joining them as well!

3. Conclusion

The UAS scheme has been shown to enthuse final year undergraduates, allow them to make informed decisions regarding a career in teaching. The scheme provides appropriate young role models to school students and provides an invaluable source of current chemical information for their teachers. The UAS participants gain a myriad of transferable skills which is what a traditional final year research project student would receive. In addition, these students gain interpersonal skills and the ability to communicate science to a wide range of audiences, at the appropriate levels of understanding. The School of Chemistry (the host) derive a wide range of benefits, including satisfying the diverse requirements of our undergraduate students needs and fulfilling its desire to engage with the local community. The role of the School Teacher fellow is novel to this particular UAS programme and is shown to enhance considerably the overall experience for all participants.

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