University of Bristol

CETL Interim Evaluation report
July 2007

CONTENTS Page

INTRODUCTION

1. Background

This self-evaluation report combines information about the progress of the AIMS and ChemLabS CETLs. The University's purpose in providing a joint report is to emphasise the synergy between the two CETLs that has been facilitated by the additional HEFCE funding. The joint report also enables some contrasts and comparisons to be made, as would be expected given the different structures and disciplines that exist in the CETLs. One fundamental difference should be mentioned here: the AIMS CETL is led by the Departments of Anatomy and Physiology and involves staff from three further departments (Pharmacology, Clinical Medicine and Oral and Dental Science), therefore five subject groups in two faculties are contributing to the CETL. The ChemLabS CETL is based in one department, the School of Chemistry. Benefits and challenges arise in both structures, as can be seen from the individual CETL sections below, and from the overall conclusions.

For each evaluation component, we have provided what we think is appropriate evidence on which to base our comments. Methods include: questionnaires, focus groups, one to one interviews, analysing the impact of CETL activities on student achievement and staff development, counting the number of external enquiries about CETL activities, etc. In some areas, we have already been able to collect ample evidence (for example, on the impact of the AIMS Human Patient Simulator and on the effects of outreach and the School Teacher Fellow in respect of ChemLabS). Evidence it has not been possible to collect in large quantities includes quantitative information on how the CETLs are affecting student learning; we have begun to evaluate this but it will take several years to gather data that might be considered as conclusive evidence.

2. Structure, format and audience

The report is structured in four main parts: a general 'University Overview' section that applies to both CETLs; a section about AIMS; a section about ChemLabS; general conclusions that draw on evidence from both CETLs. It is intended to provide both a summary of preliminary conclusions about progress made at the level of the two CETLs and at University level and is also intended to help inform HEFCE's wider evaluation of the CETL programme (note: ChemLabS was one of the CETLs visited by a team from Lancaster University and the Open University in July 2007 to gather information for the overall CETL programme evaluation).

In writing this report we have taken account of the proposed reporting format provided by Lancaster and the Open Universities. We have not followed those structures exactly, but hope that the report is written in such a way that makes it possible to map the contents to the headings given in the HEFCE guidance for interim evaluation reports[1].

We have used a similar evaluation framework and approach for both CETLs. The framework and guidelines for the external evaluator for the Bristol ChemLabS CETL are included as **Annex 1**. The framework for the AIMS CETL is similar. The four main evaluation themes are:

- Student learning opportunities and achievements

[1] *Centres for Excellence in Teaching and Learning (CETLs): approaches to evaluation* http://www.hefce.ac.uk/learning /tinits/cetl/evaluation/CETLguide.pdf

- The impact of the CETLs' teaching and learning approaches — at department, faculty, University levels and externally
- Outreach and widening participation activities
- Continuing professional development for University staff, external teachers and health professionals

While we hope that the report will be accessible to wider audiences, it has been written explicitly to fulfil the terms of formal HEFCE evaluation of the CETLs.

3. Further information, dissemination and sustainability

3.1 Sources of further information

Our aim has been to keep this report as concise as possible. We have therefore referred throughout to additional sources of information as reference points. The report is being made available in full on both CETL websites[2].

Other reports that inform this self-evaluation include:

- Progress report for the Applied and Integrated Medical Sciences Centre for Excellence in Teaching and Learning (AIMS CETL), April 2005 to January 2007[3]
- Bristol ChemLabS Annual Reports[4]

3.2 Dissemination

Dissemination is being achieved through several strands of CETL activities, as noted in the separate CETL reports below. To summarise, this includes:

- Visits from other institutions / constituencies to CETL facilities and to observe teaching tools and methods
- Education Guardian Online, BBCi News Online, BBC World Earth Report, the Bulletin of the Royal College of Surgeons of England, and in local press and TV reports in the south west.
- Use of the Mobile Teaching Unit (MTU) at numerous venues including a range of secondary and primary schools and the Cheltenham Science Festival, as a showcase for cutting edge, inspirational science teaching

3.3 Sustainability

The University and both CETLs realise that issues of sustainability need to be addressed to assure the successful continuation of CETL activities once external funding has come to an end. We wanted to be proactive and to ensure that we could differentiate clearly between open source 'products' and those that could be income-generating. Therefore Bristol ChemLabS sought the early advice of HEFCE, inviting Alan Palmer to a meeting to discuss sustainability, intellectual property and income generation. This was a very helpful exchange and very soon afterwards,

[2] http://www.bris.ac.uk/cetl/aims and http://www.chemlabs.bristol.ac.uk
[3] http://www.bris.ac.uk/cetl/aims/home_pages/resources_html
[4] http://www.chemlabs.bris.ac.uk/Documents/

HEFCE was able to issue clear and practical guidance on this topic[5] which we are using to inform our sustainability strategy.

Examples of sustainable practice already emerging from CETL activity are:

3.3.1 Immediate cost savings and income generation

The University has been able to reduce its spending on anatomy demonstrators by about £50k per year as a result of the use of the AIMS Clinical Anatomy Suite, which has also been used as a venue for prestigious, income-generating postgraduate surgical courses. We are hoping to increase this activity in the future.

The Human Patient Simulator Teaching Suites have hosted income-generating external courses and summer schools. This activity is also planned to increase in the future.

3.3.2 Commercial sponsorship of outreach and appointment of School Teacher Fellow

Bristol ChemLabS has secured commercial sponsorship of outreach activities and are putting together a business plan to include continuing support from a range of organisations to sustain outreach in the longer term. When we appointed our School Teacher Fellow, Tim Harrison, it was anticipated that as well as being involved in outreach, he would be able to contribute to a range of other CETL activities, from curriculum development to dissemination. This has indeed occurred and a more detailed section on the School Teacher Fellow role can be found in the Bristol ChemLabS section below. The model has been adopted by other organisations and subjects, and Bristol ChemLabS is working with the Royal Society of Chemistry on rolling out the model through the Chemistry for our Future initiative.

There are two further points to note here in respect of sustainability: a) we are trying to recover the cost of the School Teacher Fellow's salary through outreach activities — this is beginning to have an effect and we anticipate that we might cover the full cost over three years; b) we have become aware that although other disciplines are keen to adopt the school teacher fellow approach, there are barriers to take-up around the shortage of science teachers in schools and the ability of professional bodies to fund fellowships.

3.3.3 Capital and recurrent investment — Bristol ChemLabS

The impact that the award of the CETL funding for Bristol ChemLabS has had on further capital investment in the School of Chemistry cannot be understated. The award has triggered additional investment by the University of Bristol of £14m to cover a variety of associated building projects that relate to both teaching and research. It is unlikely that such an investment would have been made at this time had the School of Chemistry not been successful in its bid to become a CETL. The CETL programme has therefore acted as a powerful catalyst for internal capital investment. The factors behind this outcome will be explored later in this self-evaluation report.

The Bristol ChemLabS team is also currently negotiating with commercial sponsors for additional support to help sustain our activities beyond the period of recurrent CETL funding. The project forms one of the centrepieces of the University of Bristol's 2009 Centenary Fundraising Campaign and has already attracted a lot of interest from potential sponsors. It is evident that sponsors not only want to support the aims and objectives of the Bristol ChemLabS project, both in terms of delivering excellence in teaching and promoting practical chemistry

[5] http://www.hefce.ac.uk/learning/tinits/cetl/ipr/IPR_dissemination.doc

through outreach work, but also want to be associated with a project that is recognised by HEFCE as being at the forefront of educational innovation and development. For example, our first commercial sponsors, Shimadzu, appreciate readily the value to their company of being associated with a project that aims to provide the best possible undergraduate training in practical chemistry. Indeed, Colin Jump, Managing Director, Shimadzu UK, commented formally when agreeing to the sponsorship

> *"I am very impressed with the investment from both HEFCE and the University of Bristol in the Bristol ChemLabS CETL. Shimadzu is delighted to be associated with such an important venture which I am sure will have a huge impact on the teaching and learning of practical chemistry in higher education and beyond."*

Being formally recognised as a Centre for Excellence in Teaching and Learning has clearly helped demonstrate these credentials.

4. Evaluation framework and approach

4.1 Coordination and development of evaluation policy and practice

Evaluation of each CETL is being coordinated by an Evaluation Working Party that consists of members of the respective CETL's Management Board. The membership of each working party, included as **Annex 2** to this report, has been chosen to represent not only academic staff with a subject specialism in each CETL's discipline(s), but also staff from elsewhere within the University of Bristol who have a broader expertise in evaluation, and educational development and research. The working parties have been meeting regularly to review policy and practice in evaluation. They report to formal CETL Management and Advisory Board Meetings.

The Evaluation Framework at **Annex 1** has been developed to ensure the efficient and effective evaluation of all aspects of the Bristol CETL projects. The Framework provides details of the mechanisms for each stage of the evaluation, from the collection of baseline data to the analysis of the information obtained. It has since been used by both the Royal Society of Chemistry and the Higher Education Academy as a model for the development of their own evaluation strategies.

4.2 Monitoring, evaluation and research

The Evaluation Framework makes a clear distinction between monitoring, evaluation and research. We believe that whilst monitoring and evaluation must be performed by the internal teams in order to be truly effective, research may, and indeed in some cases should, involve external partners. Both CETL projects offer valuable opportunities for educational research. Subsequent sections refer to educational research projects in which both Bristol CETLs are engaged. Further topics for research may be identified from the evaluation process, and the data obtained in evaluating the project may also be useful for research purposes.

The evaluation of outreach activities is a particular challenge. The impact and effectiveness of such activities are difficult to assess without a long-term evaluation that follows cohorts of students through primary, secondary and tertiary education into employment. We have therefore tried to include in our framework strategies for evaluation of outreach activities in the short- and medium-term. Whilst the approach that we have adopted will tend to yield qualitative, rather than quantitative data, we believe that it will still be valuable in evaluating the effectiveness of

our outreach activities and informing decisions on future developments. The information that we collect as part of this evaluation could, of course, form a major part of any future longer term quantitative assessment.

4.3 AIMS

4.3.1 Research

Our new teaching facilities are providing the potential for a variety of educational and discipline-based research projects.

One important area of research is evaluation of the fidelity of the data generated by the Human Patient Simulator (HPS) against corresponding *in vivo* human data published in the scientific literature. Although the HPS is already used by a number of medical centres for clinical training, AIMS is one of only three centres globally that are using the simulators for 'pre-clinical' basic medical science teaching. The latter requires not only qualitative, but also accurate quantitative, correspondence between simulated and real data so that students can carry out realistic numerical analysis, including graphical representation of the simulated physiological and pharmacological parameters. Our early findings suggest that the validity of the base software model could be improved by adjusting some of the underlying modelled physiological parameters and relationships. We are hoping to be able to work with the manufacturers of the HPS to update the software model in light of these findings — to the benefit of our own teaching and that of any other HEI or medical school using the HPS for either medical sciences or clinical teaching. Aspects of this research have been developed as final year BSc undergraduate research projects and, to date, five of our third year physiology students (all of whom have now graduated with First or Upper Second Class degrees) have carried out a project in this area.

We are also interested in exploring the benefits of using the Human Patient Simulators for 'spiral' learning. From October 2006, the AIMS Centre HPS teaching suites (rather than local hospitals) are providing the venue for existing HPS-based clinical training for 'senior' medical students as well as hosting new medical science 'pre-clinical' teaching for the more 'junior' students. Future cohorts of senior clinical medical students will thus already have received pre-clinical, simulator-based teaching in the same venue as is used for their clinical training. They will therefore be familiar with the manikin and associated equipment. We have started some longitudinal cohort analysis to investigate whether their prior 'pre-clinical' experience will enable them to make better use of their 4th year clinical training compared with previous student cohorts.

The Clinical Anatomy Suite facilities have enabled us to alter our practical anatomy classes, whereby half the session is taught in the traditional way, in small groups around the body, and the other half is taught in the form of Directed Self Education (DSE), using models, Computer Aided Learning tutorials, images and anatomical sections. Our experience from the first year of operation is that many students prefer "passive" learning, and encouraging them to engage with the DSE can be challenging. Research is being undertaken, based on sampling student feedback and performance as well as staff experience, to evaluate different formats for the DSE, and how best to integrate the DSE with small group teaching.

The new facilities within the Clinical Anatomy Suite have also enabled us to introduce a new style of research project into the final year of our undergraduate anatomy degree programmes, where the core activity will involve preparation of museum-quality dissections, coupled with a reflective report into how the dissections will help support integrated medical teaching and/or contribute to anatomical research. Research will be undertaken to compare the learning

experiences and achievements of students undertaking these projects, as compared to the more traditional lab-based projects.

Another interesting area of educational research is to compare students' response to learning histology with the computer-based 'virtual' microscope compared to using a traditional light microscope. Both approaches have strengths and limitations and we plan to solicit students' views as well as to track their achievements with each approach.

4.3.2 The role of external evaluators

Unlike Bristol ChemLabS, AIMS has decided not to appoint an academic subject-specialist as an external evaluator. It was felt that no single individual could represent the breadth of disciplines represented within AIMS. Instead, Dr Stephen Greenwood, the Course Director for the University of Bristol Teaching and Learning Programme for Health Professionals, has been appointed as an evaluator who is external to AIMS, although internal to the University. Dr Greenwood is an experienced medical educationalist and is also a Fellow of the Higher Education Academy. He is therefore able to provide objective evaluation of the various AIMS initiatives from a medical education perspective. Ms Gill Clarke, Director of the University Education Support Unit, is also a member of the AIMS Evaluation Working Party and provides considerable expertise in the evaluation of generic issues of learning, teaching and assessment.

4.4 Bristol ChemLabS

4.4.1 Research

We have identified a number of research areas that we wish to investigate further. For example, we are particularly interested in the use students make of the electronic and paper-based resources available to them. We are therefore exploring whether some students still prefer to use a paper copy of the laboratory manual, in spite of the fact that it is readily available in an interactive format at each bench as the Dynamic Laboratory Manual. We have also established a link with the CETL in Experiential Learning in Natural and Environmental Science at the University of Plymouth to explore various aspects of practical teaching. The Plymouth team are investigating the evidence for the assertion that laboratory and field work forms an essential part of the teaching and learning process for certain scientific disciplines. At the same time, they are also trying to find ways of enhancing a student's experience of such activities. Bristol ChemLabS will form a case study in their project, allowing the Experiential Learning team to make comparisons between different activities across the full range of physical, biological and environmental sciences. By engaging in such a partnership, we will be able to build upon and exploit the established expertise of the Plymouth team in the fields of social science and educational research.

4.4.2 The role of the external evaluator

Dr Stuart Warren of the Department of Chemistry at the University of Cambridge has been appointed as the External Evaluator for the project. Dr Warren has many years of experience in teaching chemistry and has a particular interest in practical work. In selecting as our External Evaluator an academic subject specialist rather than an educational researcher or professional evaluator, we are aware that we have chosen a different approach to most other CETLs. We believe, however, that this approach is the most appropriate given the particular nature of the Bristol ChemLabS project. Dr Warren will be expected to provide an independent assessment of all areas of CETL activity at key stages in the project. His expertise means that he is able to

comment in detail on subject-specific processes and student achievements as well as broader educational matters. He will not, however, be expected to help in the development of strategy or contribute directly to implementation because the aims and objectives, and the methods by which they are to be achieved, were precisely defined when the initial bid for CETL funding was first submitted. Furthermore, although the achievements of the Bristol ChemLabS project will be of interest to those teaching subjects other than Chemistry, the immediate focus is subject specific and requires an External Evaluator with expert knowledge. Detailed terms of reference for the External Evaluator are included in **Annex 1** of this document.

4.4.3 Reflections on the evaluation process

The value of a proper, rigorous approach to evaluation has recently been highlighted by two post-mortem sessions held to review both the positive and negative experiences of students and staff in Level-1 and Level-2 laboratory classes. Representatives of the undergraduate and postgraduate student focus groups were invited to join with technical and academic staff, as well as members of the Bristol ChemLabS team, to discuss all aspects of the laboratory elements. These sessions proved very valuable and provided more constructive feedback than the responses we had already obtained from student questionnaires. It was clear to all involved that such discussion is critical in meeting the aims and objectives of our evaluation framework.

EXECUTIVE SUMMARY

This is the interim self-evaluation report (July 2007) for the University of Bristol, as required by HEFCE for all Centres for Excellence in Teaching and Learning (CETLs). It combines information about the progress of the two CETLs hosted by the University: AIMS (Applied and Integrated Medical Sciences) and Bristol ChemLabS (Bristol Chemical Laboratory Sciences) CETLs, two of the small number of science-based CETLs established. The University's purpose in providing a joint report is to emphasise the synergy between the two CETLs that has been facilitated by the additional HEFCE funding (a total of just over £10m), and to enable some comparisons and contrasts between the two Centres, two of the small number of science-based CETLs.

The AIMS CETL involves staff from five University departments and two faculties: from the Faculty of Medical and Veterinary Sciences — Physiology, Pharmacology and Anatomy; and from the Faculty of Medicine and Dentistry — Clinical Medicine South Bristol and Oral and Dental Science. The Bristol ChemLabS CETL is a single-subject centre within the School of Chemistry. Both CETLs are already having an impact on higher education teaching: not only in related subjects in Bristol University but also in other higher education institutions, both at staff and student level.

Following a general Introduction, the report is in four sections: University overview; AIMS Self-evaluation; Bristol ChemLabS Self-evaluation; Conclusions. As can be seen from these main sections, some significant benefits have flowed from the HEFCE investment in University infrastructure to create new teaching space for both subjects. University funding, both previously and currently, has complemented the large HEFCE investment.

Students in both CETLs are benefitting from innovative and creative technologies being integrated in their teaching and learning experience. Examples of tools, techniques and resources can be found throughout the report and include Human Patient Simulators, Dynamic Laboratory Manual, Clinical Anatomy Suite facilities, Mobile Teaching Unit, Virtual Microscope, etc. These innovations are attracting interest from other science and medicine educators in the UK and more widely; commercial links are also being established. Evidence shows that students are enthusiastic about their learning experience in the CETLs (see quotations in the text). In some cases there has been an improvement in student achievement; in other areas, the CETL innovations have enabled us to sustain the quality of teaching in the face of increasing student numbers, securing a strong platform for future developments.

Both CETLs are successfully engaged in outreach activities. These include the appointment of a Bristol ChemLabS School Teacher Fellow and using the highly innovative Mobile Teaching Unit to visit secondary and primary schools to enthuse and inspire students and encourage them to develop a deep interest in the relevant subjects. Feedback from schools has been universally positive and a further programme of visits is planned for 2007–08. Other forms of outreach include initiatives to encourage public engagement with science.

Staff development opportunities have been facilitated by the CETLs as described in detail in the Conclusions. Inevitably, there are some ongoing challenges around staffing, not least that much of the CETL activity falls on a core, yet extended, team in each CETL. This challenge links with the wider demands of sustainability as both projects progress. However, we are confident that our emerging partnerships and collaboration with industry and plans for income generation will assure continuity and support for CETL activities into the future.

SECTION 1 — UNIVERSITY OVERVIEW

Centres for Excellence in Teaching and Learning at the University of Bristol

This section highlights some of the shared vision and developments at University level that lie behind the establishment and progress made by the two CETLs. HEFCE's investment came at a time when the University had been investing steadily in teaching and research infrastructure in the CETL subjects, so was very timely in that respect. Since 2002, the University has also adopted a more systematic approach to the integration of e-learning and e-assessment across all subjects, establishing a network of e-learning representatives (one for each faculty) and securing HEA Pathfinder[6] funding to support three shared posts. These further developments are documented elsewhere[7]; they are complementary to the CETLs' development.

1. Background to CETL investment in physical infrastructure leading to education improvements

1.1 Chemistry

A major investment in infrastructure was made with completion of the £17m Synthetic Chemistry building in 1999. Whilst this brought benefits to both research and teaching, it was not in itself sufficient to transform the quality of laboratory space for chemistry teaching into space appropriate for 21st century education.

The School of Chemistry was also subject to a Departmental Review[8] in May 2002 which highlighted the need for further investment in facilities for teaching undergraduate practical chemistry. The School was commended for its excellent teaching but the review panel nevertheless recommended that it:

> "Work with the University and Faculty in prioritizing the need for new or refurbished teaching accommodation for Chemistry. This should be approached in an imaginative way, making best use of existing space.
>
> Carry out a feasibility study, in collaboration with the Bursar's Office, into the use of space in teaching laboratories so that this could be turned into a bid for funding if an opportunity arose.
>
> Develop a rolling programme of equipment replacement in the teaching laboratories."

The School therefore had sound objective evidence to present in the CETL bid that the quality of teaching and learning could be improved significantly by investment in infrastructure for chemistry teaching, in particular through upgrading laboratory space to world-class standards. In support of the Bristol ChemLabS CETL bid, the University therefore agreed to provide significant additional investment to facilitate the envisaged infrastructure developments. An extra

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[6] Details of the Pathfinder project are at:
http://www.heacademy.ac.uk/ourwork/learning/elearning/pathfinder

[7] University of Bristol e-Learning Advisers Network (ELAN): details can be found at:
http://www.bristol.ac.uk/elan/

[8] Departmental reviews take a holistic look at departmental activities, including research, teaching, staff and financial management, organisation and structure, etc. They occur every five to six years and are intended to stimulate self evaluation and to lead to improvements in performance and efficiency.

£5m of capital funding was allocated directly to the Bristol ChemLabs project, with a further £11m to cover the cost of associated refurbishment.

1.2 Medical Sciences

Since the late 1990s the University has been upgrading teaching and research accommodation in the School of Medical Sciences and the Pre-Clinical Veterinary School which, between them, house all medical sciences subjects (Anatomy, Physiology, Pharmacology (Physiology and Pharmacology are to merge from 1 August 2007), Biochemistry and Cellular & Molecular Medicine). The building programme included £15m of SRIF funding to upgrade research laboratories and animal accommodation with around £7m University investment in practical teaching space. In 1999, approximately £2m was invested to develop a Comparative Morphology Centre containing high quality human and animal dissection facilities within the Pre-Clinical Veterinary School. In 2000, a further £5m established the School of Medical Sciences Teaching Laboratories which house excellent facilities for biochemistry, histology, pharmacology and physiology practical teaching. This upgraded teaching space provided an ideal platform for the additional teaching infrastructure changes made possible by the AIMS CETL funding.

University investment and CETL funding together thus enabled Chemistry and Medical Sciences to create world-class practical teaching space for the relevant subjects; the laboratories are superbly equipped and utilise state of the art, research-grade technology. One of the distinctive features of education at Bristol, as at other similar institutions, is its research-informed teaching and learning. The CETLs provide an example of how this is achieved both practically and intellectually.

2. The wider impact of the CETLs

Only a small number of CETLs focus on science teaching and learning. That has provided an opportunity for those CETLs to think not just about education in the individual subject, but for the wider consequences for science teaching at various levels, beginning in primary schools. For example, the School Teacher Fellow in ChemLabs has contributed to enthusing students of all ages in science through the well established Chemistry outreach programme and the AIMS Mobile Teaching Unit has had a significant impact on outreach and widening participation activities that include offering hands-on anatomy and physiology demonstrations. The CETL enhancements have had a very positive impact on each CETL's contributions to summer schools such as those run by the National Academy for Gifted and Talented Youth (NAGTY) and the Sutton Trust.

An example of effective collaboration between the two CETLs and more widely is that the Mobile Teaching Unit has been shared by both CETLs for outreach activities and is also available for use by other University departments.

These are just a few examples of the effects of the CETLs; in the subject-specific sections of the document below, we explore in detail the wider impact made by the CETLs, both internally and through external activities, including outreach and widening participation.

For the purpose of educational research, Bristol ChemLabS has made links with the Experiential Learning in Natural and Environmental Science CETL at the University of Plymouth in connection with their project to investigate whether laboratory and field work form an essential part of the education process for scientific disciplines and how such experiences can be

improved. Bristol ChemLabS is also working with the CELS CETL at Nottingham Trent University to share experience on educational outreach and the role of school teacher fellows.

Annex 3 highlights some of the most significant outputs of the CETLs to date, summarising publications, conference presentations and individual staff awards.

3. Impact on reward and recognition processes

The University of Bristol has recently introduced a new career structure for academic staff that combined separate pay and grading scales. These scales previously applied to staff performing conventional academic roles that included research, teaching and administration as well as those designated previously as academic-related that perhaps focussed on only two, or in some cases, one of these three elements. The new structure replaced these with just one scale with three career pathways. Pathway One applies to staff who have a contractual obligation to perform research, teaching and administration and follows most closely the traditional and long-accepted career profile of a member of academic staff. The emphasis on both research and teaching means that the majority of existing members of academic staff within the University of Bristol are deemed to be following Pathway One. Two additional pathways have, however, also been established. Pathway Two applies to academic staff whose contractual obligations relate primarily to research, whilst Pathway Three is for those whose responsibilities lie in teaching. All three pathways follow a similar structure, with the possibility of progression to the level of Senior Lecturer and then promotion to Reader or Professor. Transfer between the three pathways is possible, but not automatic, especially at the most senior levels.

The creation of Pathway Three is an important development for a research-led university such as Bristol. The new scheme recognises the importance of such staff in delivering excellence in teaching, as well as allowing staff on Pathways One and Two to devote more time to research. However, it also acknowledges that appointment of academic staff to Pathway Three might be more appropriate in some disciplines than others. By establishing a largely teaching-related career pathway that allows promotion right through to the position of Professorial Teaching Fellow, the new strategy formally values the important contribution of such staff to the University. For the first time, it places the excellence and achievements of staff engaged primarily in teaching on a par with those engaged primarily in research.

It is, of course, difficult to determine the precise impact of the Bristol ChemLabS and AIMS CETL projects on the development of this new career structure and the creation of Pathway Three in particular. However, as outlined in other sections, both CETLs have had a considerable impact within the University by raising even further the status of teaching and learning and illustrating some existing effective practice. The formal recognition by HEFCE that certain departments within the University are national leaders in delivering excellent and innovative teaching is powerful support for the development of a career strategy that rewards and recognises the staff involved appropriately. It is therefore appropriate that some of the first senior promotions for staff on career Pathway Three have been made to those from the two CETL teams: Dr Paul Wyatt, the Bristol ChemLabS Director has been promoted to reader, whilst Dr Dudley Shallcross, the Bristol ChemLabS Outreach Director and Dr Judy Harris the AIMS Director have both been promoted to professor, as from 1st August 2007.

SECTION 2: AIMS — Self-Evaluation

1. Background to the self-evaluation

1.1 Objectives

The focus of the AIMS Centre, as identified in the Stage 2 bid to HEFCE, is practical-based medical sciences teaching and learning. Its objectives are to:

- Establish first-class medical science educational facilities that provide a local and national resource;
- Develop a range of innovative approaches to medical sciences teaching and learning, and to embed these within the existing curriculum. Many of these innovations are based on either physical or 'virtual' models, images and simulations of human and animal structure and function;
- Disseminate information about the AIMS Centre, and make its facilities available to a wide range of stakeholders through outreach activities with schools, other HEIs, postgraduate and other health professionals, learned societies and the general public;
- Undertake educational and discipline-based research and to disseminate the outcomes of this at conferences and through the scientific and medical education literature;
- Evaluate generic aspects of the impact of the AIMS CETL on teaching and learning, staff development and career progression, student recruitment and the evolution of institutional policies within the University of Bristol;
- Evaluate the individual AIMS teaching and learning initiatives in terms of their impact on student learning and achievement, student and staff satisfaction, efficiencies in the use of resources for teaching and learning, and the adoption of similar approaches and / or use of AIMS facilities by other institutions;
- Sustain AIMS Centre activities by generating income through business development and other fund-raising activities.

1.2 Management and governance of the AIMS Centre

Leadership and direction of the AIMS Centre is provided by the Directors, Dr Richard Greene and Dr Judy Harris. Dr Greene leads on initiatives related to anatomy whereas Dr Harris provides the lead on physiology, pharmacology and histology initiatives. To strengthen operational coherence across the CETL we propose to expand the senior management team from summer 2007 by appointing a 0.5 FTE AIMS CETL manager. This role will be taken on by Dr Jonathan Wakerley when he reduces his existing full-time academic post to 0.5 FTE. Dr Wakerley is ideally suited to the role of AIMS manager as he is a core member of AIMS and has considerable managerial experience in an academic environment. He will take responsibility for AIMS budgetary and personnel issues, business development and co-ordination and dissemination of the various academic initiatives within the CETL. He will also represent AIMS at appropriate networking events and workshops hosted by HEFCE, the Higher Education Academy and its Subject Centres.

Support for the AIMS Directors is also provided by a cross-disciplinary Management Board. This is chaired by the Dean of the Faculty of Medical and Veterinary Sciences and includes

representatives from the three medical sciences departments that contribute to the CETL (Anatomy, Physiology and Pharmacology), the Director of the University Education Support Unit and the Faculty Accountant. Strategic guidance for AIMS is provided by an Advisory Group, chaired by the Pro-Vice Chancellor for Education, that includes all members of the Management Board, the Faculty Education Director, the ChemLabS Chief Executive and senior representatives of bodies external to the university such the Royal College of Surgeons, the Subject Centre for Medicine, Dentistry and Veterinary Medicine and the University of the West of England. The Advisory Group also includes undergraduate student representatives from the relevant degree programmes. The Management Board meets at least quarterly and the Advisory Group meets twice per year. Administrative support for all AIMS activities is provided by a full-time, dedicated administrator/secretary.

A number of 'Project Facilitation Groups' have also been established as the various AIMS initiatives have evolved. These include:

- A 'Mobile Teaching Unit Steering Group' with representation from academic and support staff within the two University of Bristol CETLs (the AIMS Centre and Bristol ChemLabS);
- A 'Human Patient Simulator Users Group' with representation from academic and support staff within Physiology, Pharmacology and Clinical Medicine;
- A 'Virtual Microscope Users Group' with representation from academic and support staff within Physiology and Anatomy;
- An 'Outreach Group' that co-ordinates outreach activities with local schools. This includes representation from Anatomy, Physiology and Pharmacology.

These groups have been useful sources of information for this self-evaluation. Their members are at the cutting edge of CETL development and therefore they are able to give a valuable insight into both positive outcomes, including unintended consequences, and challenges for the future.

Additional Project Facilitation Groups may be established as the CETL activities expand and evolve over time.

2. Student experiences, including effects on teaching methodology, space and learning designs

Several components of the AIMS CETL contribute to the student learning experience. Broadly, these are:

- The Human Patient Simulator (HPS) and related teaching suites
- The Bristol Clinical Anatomy Suite (CAS) (which includes a high quality Pathology Museum)
- The Virtual Microscope (VM), with underpinning digital image archive

These components are both separate and, for many students, inter-related, depending on the student's programme. For example, first and second year students on the MB ChB programme (who are training to be medical doctors) are already benefiting from all three of these initiatives; first year veterinary science students have used both the Human Patient Simulator and the Virtual

Microscope, whilst students on several medical sciences programmes have received teaching only from the HPS. In all, over 1,000 undergraduates across a range of degree programmes are already benefiting from one or more of the AIMS teaching initiatives.

Below is some initial evaluative information about each of the three components referred to above.

2.1 Human Patient Simulators (HPS)

These are now embedded in our physiology and pharmacology teaching for first and second year medical, dental, veterinary science and medical science students. We have developed a number of physiology and pharmacology teaching scenarios that extend and enhance our more traditional practical and tutorial teaching. The scenarios, which target principally the cardiovascular and respiratory systems, are evaluated during their development by student focus groups — this initial evaluation provides very useful student feedback that enables us to 'tweak' the scenarios before they are used in timetabled teaching. The HPS-based teaching is attracting excellent student feedback, as shown in Figure 1 which illustrates the responses of 475 first year students across the medical, dental, veterinary science and a range of medical sciences programmes who were asked to evaluate a range of learning and teaching formats for their effectiveness in learning cardiovascular physiology.

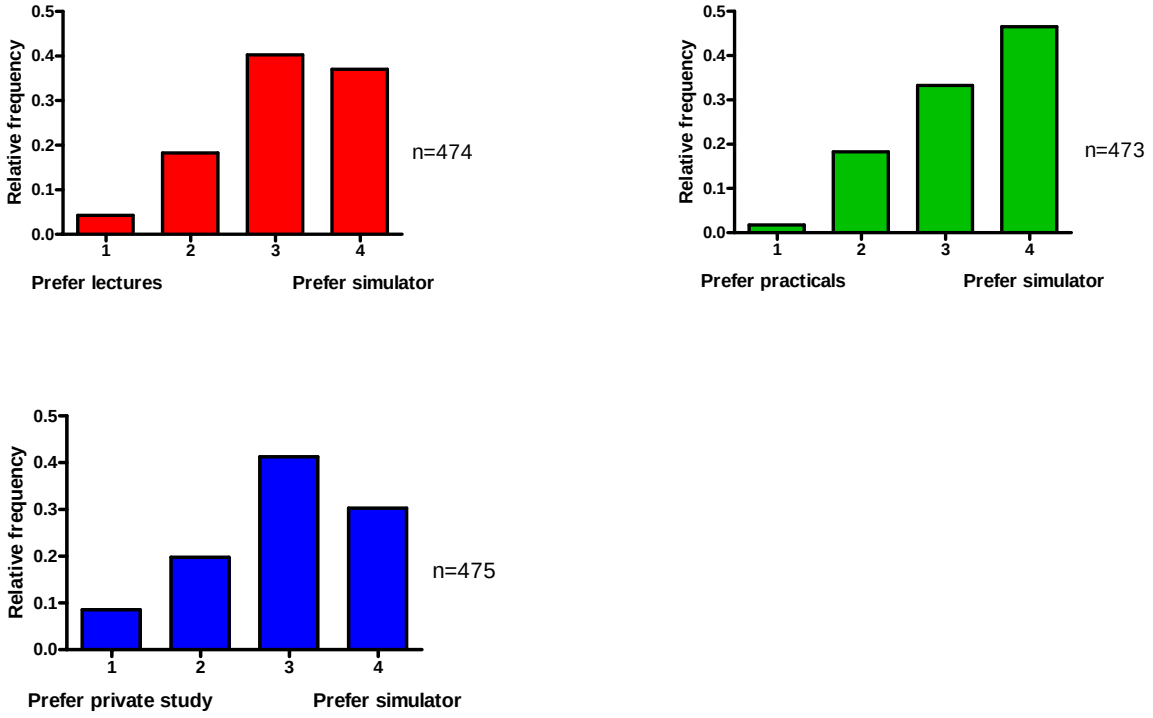

Fig 1. Learning and teaching preferences expressed by 475 first-year students

We are also using the Human Patient Simulators for more clinically oriented training of 4th year medical (MB ChB) students and we are evaluating their feedback for a number of reasons. Firstly, we wish to obtain student feedback on each 'stand alone' teaching session. Secondly, we hope to carry out a longitudinal study to assess the benefit, to such senior clinical medical

students, of prior exposure to HPS-based teaching in the early pre-clinical years. For the next two academic years, most of our 4th year medical students will not have 'met' a patient simulator before and some of them initially feel uncomfortable interacting with the manikin. By contrast, future cohorts of clinical students will, through the CETL facilities, already have experienced HPS teaching in their pre-clinical years. Such students may therefore derive a more effective learning experience in the clinical part of their programme than 'naïve' students who are meeting a simulator for the first time. Thirdly, we are exploring whether clinical medical students would welcome more (or less) of their teaching being delivered with the HPS.

Students were asked six questions, as outlined in the table below (Figure 2). The responses indicate that:

- compared with other teaching and learning formats with which they were familiar, the students preferred the HPS format (Q3);
- on the whole, the simulation session lasted for about the right time (Q4);
- the students' levels of 'uncomfortableness' with the HPS as a learning tool diminished with familiarity (Q5)
- the majority of students found it relatively easy to interpret the physiology displayed by the HPS

Q1 **Did you intercalate*?[9]	**Q2** ***Have you met the HPS before*?	**Q3** *I would prefer to cover the material in the following format*:	**Q4** *The simulation session was:*	***Q5*** *How comfortable were you interacting with the HPS: a) at beginning; b) end of session*	**Q6** *Rate the ease with which you could interpret the physiology displayed*
Yes: 36	Yes: 12	Lecture: 1	Too long: 22	Very uncomfortable: a) 4 b) 1	Very difficult: 0
No: 76	No: 100	Small tutorial group: 12	Too short: 0	Rather uncomfortable a) 35 b) 3	Quite difficult: 12
*Whether or not the student had intercalated or met 'Stan' before have not been used as factors in this set of data but we plan further evaluation to compare intercalating students' views with those of non-intercalators.		Simulator scenarios: 106	About right: 90	Fairly comfortable: a) 59 b) 64	Fairly easy: 74
		E-learning: 0		Very comfortable: a) 14 b) 43	Very easy: 21
		Private study: 1			

**** Most of the students in this cohort had no previous experience of HPS-based teaching and thus provide a 'naïve' control sample in relation to the longitudinal survey described above.

Fig 2. Summary of student feedback from 4th year medical students for clinical training sessions using the Human Patient Simulator

[9] Intercalation is when a student from a professional medical, dental or veterinary programme takes a year out of the professional programme to study a science subject, usually in their third year. To be accepted for intercalation, the student has to have achieved high marks in his / her results so far; intercalating students are therefore very able contributors to the BSc programme they join.

We are encouraged by these initial results, and particularly by some of the students' additional, qualitative comments:

"It was just like talking to a patient."

"Able to see effects of treatment, more realistic."

"It offers an opportunity to ask questions more freely"

"More likely to learn and remember because it's visual"

"Puts lectures into clinical perspective"

"Useful to watch physiology change in real time"

In addition, students were able to suggest a variety of additional medical scenarios and conditions that would be appropriately taught using the HPS, showing us that this new teaching tool had stimulated their thinking about different clinical situations.

We have also started to evaluate the HPS in terms of student learning. Around 400 first year students across a range of degree programmes (BSc medical sciences, Dentistry and Veterinary Science, see Figure 3 below) were set the same physiology data interpretation question on two occasions. The question was set immediately before a teaching session in which material relevant to the question was delivered using the patient simulator. The same question was then included in a summative examination held 3 months later. Figure 3 represents the students' scores before, and then 3 months after, the teaching session. The scores provide indicative evidence that the students' knowledge, and their retention of the material, has benefited from the HPS-based session.

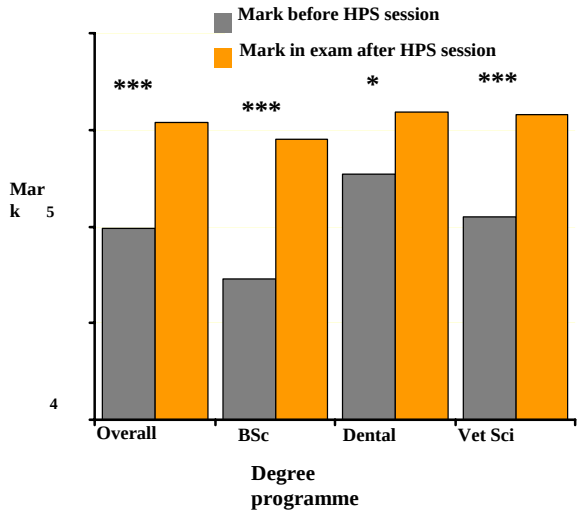

Fig 3. Average student scores (out of 6) for a physiology data interpretation question before and after a Human Patient Simulator teaching session. *** p <0.001 (Mann–Whitney non-parametric test)

In a different degree programme, 250 first year medical students were asked what they had enjoyed most about the element on the Cardiovascular System. The HPS ('Stan'), was very popular, for both enjoyment and as an effective learning tool, particularly the haemorrhage simulation session. Typical responses were:

"Most of the practicals were very interesting — particularly the 'Stan' practical to consolidate ideas".

"The best part of the course was the haemorrhage simulation session, because it really brought everything together and helped me to conceptualise the traces and what they actually mean."

"The haemorrhage simulation is an excellent learning tool and would be greatly beneficial in further years".

"The haemorrhage simulation session was interesting and I found that I learnt a lot more from this practical than from lectures and private study".

"I would have liked another session with 'Stan'".

"I especially enjoyed the simulation session".

In answer to the question '*How could the course be improved?'* the following responses were typical:

"I understand that there are plans to move all of the practicals onto Stan. This would be a great improvement as observing the simulator was a very worthwhile experience"

"More time spent with the Stan simulator"

Again, we are encouraged by this because our experience is that enjoyment leads to deep and effective learning.

2.2 Bristol Clinical Anatomy Suite (CAS)

After the design and construction phases, the CAS came on stream for undergraduate teaching in February 2007. This was several months later than originally planned, partly owing to some difficulties concerning the interface of the new building work with other developments on the site. Work is ongoing to integrate the new facility within medical anatomy teaching, and to develop an appropriate support framework for servicing the facility (computer software, maintenance of specimen collections, etc.) The CAS has numerous novel features, including:

- Innovative operating tables
- Bespoke imaging system
- Custom database of images, radiographs, tutorials and video
- Dedicated, cross-sectional anatomy / radiology workstations
- Integrated anatomy and pathology museum
- BrainTower functional neuroanatomy system

Initially the CAS has been used for systems-based anatomy teaching for second year medical students. The teaching sessions have been completely re-organised to include directed self-education (DSE) sessions in CAS and much work has gone into developing appropriate material to support them. Starting in October 2007, final year medical sciences students (a significant proportion of whom will be intercalating medical students — see above), will have the opportunity to complete an advanced anatomy / pathology dissection in the CAS.

Much progress has been made in incorporating clinical simulations into undergraduate medical anatomy teaching. A range of models/simulations have been acquired using AIMS CETL funding, and the learning objectives of the sessions have been revised to incorporate "break-out sessions" where a relevant clinical procedure is demonstrated. The simulations have been successfully introduced into the Systems unit for (mainly second year) undergraduate medical students in 2006–07. These are:

- Cardiovascular systems: Venepuncture simulations*
- Respiratory system: Laryngoscopy simulators
- Digestive system: Masticatory muscle models
Rectal examination simulators*
- Renal / Reproductive systems: Catheterisation simulators

*designed and created by Professor Andy Levy (Faculty of Medicine and Dentistry)

In addition, an ever-expanding collection of pathology specimens has been incorporated into undergraduate teaching. Use of these clinical simulation models in anatomy teaching has received very positive feedback from both students and staff.

Development of the CAS has involved large-scale changes in the accommodation, personnel and resources required to teach clinical anatomy. To enable progress to be assessed, the 2007 cohort of second year medical students sat the same anatomy practical examination as the 2006 student cohort. There was no statistically significant difference between the marks achieved by the two groups, which we interpret as demonstrating that these fairly radical changes have been introduced without compromising student achievement. This provides reassurance and an excellent platform from which to develop further the CAS and to aim for improvements in student achievement over time.

2.3 Virtual Microscope (VM)

The Virtual Microscope has now been used in several degree programmes and in a range of learning contexts. The latter include teacher-led histology practical classes, self-directed learning/revision and formative (and summative) assessments.

In the second year dental oral biology unit, conventional light microscopes have now been completely replaced by the VM in histology practical classes. Because our dental intake recently increased from ca. 50 to ca. 85 students per year, we are no longer able to provide each student with the specialist oral tissue samples required for light microscopy. However, the VM has enabled the very best oral tissue sections to be scanned and the digital images to be made available to the whole class. Preliminary data suggest that use of the VM had no effect, positive or negative, on students' assessment results, i.e. their ability to recognise and describe oral histology was unchanged. However the impact of the VM on students' enjoyment of learning was significant. Student feedback about teaching oral histology with the VM was exceedingly positive, with some responses even including constructive advice about how to further develop teaching techniques using the VM.

The VM has been introduced more gradually into histology teaching for medical and veterinary science students. Many practical sessions have used both conventional light microscopy and the VM in complementary ways and this has enabled students to make direct comparisons between

the two approaches. The majority of students prefer the VM computer-based system as the following quotes from a cohort of 110 first year veterinary science students demonstrate:

> *"I prefer the computers to microscopes in general because all students get a standard image to work from whereas some microscope slides tend to be of better quality than others"*
>
> *"The computers were much more successful as you can be sure of what you are looking for and it is easier for the lecturer to point out important points. Also we can come back to things we have missed to revise"*
>
> *"The computer practicals are much better as everyone is looking at the same slide and so have an equal opportunity to see a good specimen. It also means that pupils can help each other more easily if needed"*

However, it is clear that many students also value the 'dual' approach:

> *"Computers were a lot clearer. However I think it is important to be able to use a microscope confidently"*
>
> *"I feel that use of microscopes should be kept as an option during practicals. I feel that microscope work is an essential part of histology. However the use of computers would clarify the use of microscope work and could be used as a good revision aid"*

The advantage of the VM for revision purposes is clearly demonstrated by the following feedback from 20 first year medical students who were required to re-sit the histology examination at the end of the year. These students had not been taught histology with the VM during the year because the relevant microscope slides had not been scanned at that stage of the unit. The digital images were, however, available by the end of the year and were made accessible to the students as an optional aid for revision. The histogram below (Figure 4) summarises the ways in which the students chose to revise.

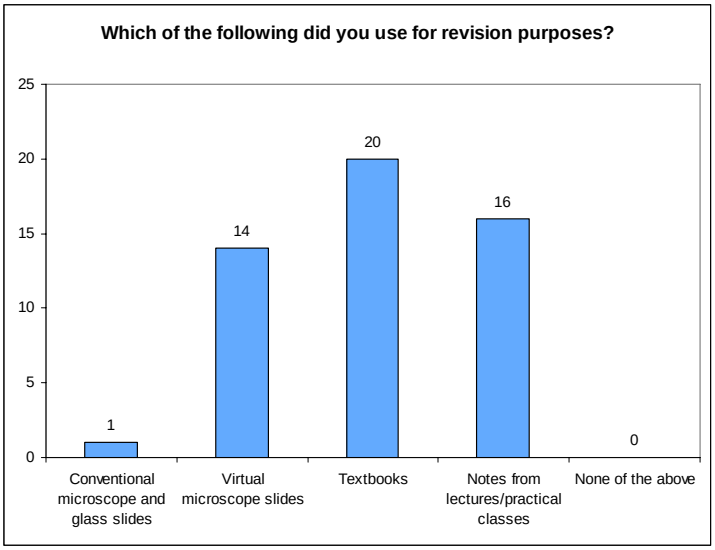

Fig 4. Revision strategies adopted by first year medical students

Of the 14 students who had used the VM, 6 rated its ease of access as 'excellent', 7 as 'good' and one as 'satisfactory'. Twelve of these students accessed the VM from home, indicating its utility

as a distance learning tool and more than half of them said that the availability of the VM had significantly reduced their need to use a conventional light microscope for revision purposes (a need that is difficult to satisfy at that time of year). All 20 students passed the re-sit histology examination and it is likely that this success rate is attributable at least in part to the availability of VM-based online revision material.

3. Connections with and effects on external partners and the wider education community

We are developing links with external partners in relation to a number of individual CETL activities. These include the Mobile Teaching Unit, the Intercalators' Conference held in April 2007, the Clinical Anatomy Suite, the Human Patient Simulators and the Virtual Microscope. We also have strong links with other CETLs, the Higher Education Academy, learned societies and professional bodies. The sections below summarise some of the key features relevant to evaluation.

3.1 Mobile Teaching Unit (MTU)

As mentioned earlier in the report, the MTU has been used not only by AIMS staff but also in partnership with Bristol ChemLabS. It is also available for use by other departments in the university. The following are examples of visits to schools and science festivals during 2007[10].

7th February 2007

Visit to Stroud High School (Dr Alice Roberts and Sarah Gosling)

Year: 12/13; approximately 120 students

Topic of sessions: 'Anatomy of the Cardiovascular and Respiratory Systems'

Quotation from year 12 student:

> *"I attended a seminar in the lorry with Dr Roberts and around ten other AS and A2 Biology students. We learnt about the anatomy of the cardiac and respiratory systems in mammals. The session was very interactive, giving us the opportunity to use stethoscopes to listen to our heartbeats and see artefacts such as a lioness' skull when studying the passage of air into the lungs … All in all the day was varied, informative and — most of all — fun! I was fortunate to have the opportunity to talk to Dr Roberts at the end of the day about careers and university courses in her field. The anatomy seminar had inspired me to look further into studying anatomy or physiology at university, as I have always been fascinated by the way the body works.*"

23rd April 2007

Visit to The Crypt School, Gloucester (Dr Alice Roberts, Lauren Hughes and Sarah Gosling)

Year 12/13; approximately 60 students

Topic of sessions: 'Anatomy and Physiology of the Heart'

Feedback from Chemistry teacher:

[10] Further details can be found at: http://www.bris.ac.uk/cetl/aims/mobile_lab/index_html and http://www.bris.ac.uk/cetl/aims/home_pages/news_html)

"*Monday was fantastic. We have had such amazing feedback from pupils, parents and staff. Everyone was really impressed with the day. Please say a massive thank you to Alice, Lauren and Sarah for all the work they put into the day*."

25th May 2007

Visit to St Peter's School, Portishead (Lauren Hughes and Sarah Gosling)

Year 5/6; approximately 120 students

Topic of sessions: 'The Heart'

Feedback from Year 6 teacher:

"*Thank you so much for visiting our school with your lorry. The children really enjoyed the experience and are still talking about it! It linked in really well with the work we already cover in the curriculum as well as giving the topic a boost through the hands-on opportunities it provided.*"

7th June 2007

Visit to Cheltenham Science Festival (Drs Alice Roberts, Rich Helyer and Anne Cooke)

Children, teenagers, adults, families, members of the public (and Professor Lord Robert Winston!) visited an interactive anatomy–physiology demonstration — 'Hearts and Minds' — which was presented in an entertaining but informative and thought-provoking way.

The MTU has also visited surgical conferences to display its potential for providing regional postgraduate surgical training, and to disseminate information about the facilities that are available in the Clinical Anatomy Suite. To this end the MTU was on display at the following meetings in 2007:

20th March 2007

Royal College of Surgeons Conference in London where Dr Richard Greene demonstrated the capabilities of the MTU for postgraduate teaching and also gave a talk on the Clinical Anatomy Suite.

18–20th April 2007

The Scientific Meeting of the Association of Surgeons of Great Britain and Ireland in Manchester – displays of the MTU and the Clinical Anatomy Suite.

Other opportunities to disseminate the innovative anatomy and physiology teaching enabled by the MTU have been through a live interview on Radio Bristol and local newspapers, which have run articles and photographs.

3.2 Intercalators' conference project

The overall aim of this project is to investigate and enhance the role of intercalated degrees in encouraging entry into clinical academic careers. The objectives are:

- to establish an Annual Intercalators' Conference; and
- to survey intercalation in UK medical schools, identifying arrangements which work well in providing high quality research training and thereby encouraging academic careers

An inaugural Intercalators' Conference was held on 21 and 22 April 2007. It was attended by around 70 students from 15 different UK medical schools. The programme comprised parallel presentation sessions, posters and two plenary lectures, plus a workshop to discuss the concept of intercalation.

The intercalators' conference provided the following learning opportunities, and achievements. In particular it enabled past and present intercalators to:

- Gain experience in presenting, discussing and defending their research work to a wider audience in a formal conference setting.
- Hear what others have achieved, learn about new research areas and techniques, and feel the excitement of debating and interpreting new data.
- Hear inspirational lectures from medical academics, giving personal insight into what it takes to follow a research career, and the rewards and excitement of doing research.
- Join in a debate about intercalation, put their own experiences in context, and express views on what is good and what needs to be improved.

Results of a questionnaire to evaluate different aspects of the conference are provided in Figure 5 below, and examples of individual feedback in Panel 1.

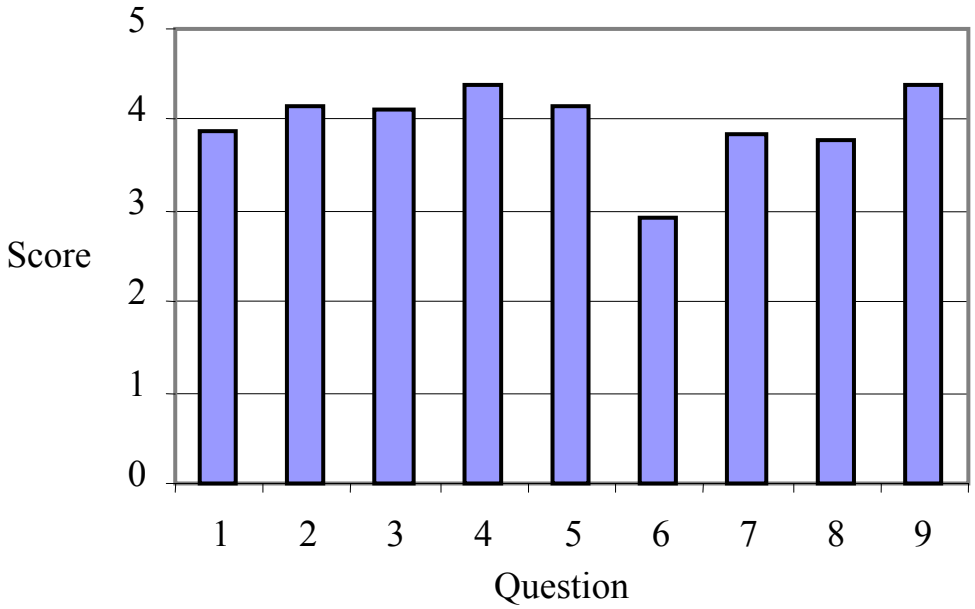

Fig. 5. Bar chart showing feedback scores for different aspects of the Intercalators Conference (1 = poor, 5 = excellent). Delegates were asked to score the following: 1. Lecture on journeying from intercalation to academic Medicine (ProfessorWynick); 2. Lecture on experiences in clinical research (ProfessorSoothill); 3. Workshop on intercalation; 4. Oral presentation sessions; 5. Opportunities to reflect on your intercalation year; 6. Opportunities to learn more about your research field; 7. Effectiveness in increasing your enthusiasm for research; 8. Effectiveness in increasing your enthusiasm for a research-orientated career; 9. Opportunities to engage with students from other schools.

I really enjoyed the weekend as it was nice to see what my peers had to say and present. Thank you very much. Definitely a worthwhile conference.

I really liked the sessions we had and it encourages students to keep things more understandable to a wider audience; I agree having parallel sessions was nice; being able to do an oral presentation was an opportunity I think many people don't get and it is a useful skill — don't cut the number of these

Really brilliant conference & weekend. Was so lovely to look back on my intercalating experience, and to meet medical students from other universities. I also learned a lot from the talks, which were very interesting. The highlight was Professor Soothill's talk — very inspiring. Thanks to Dr Wakerley, Dave Prabhu & Dr Greene for all their hard work. Brilliant.

Very good programme. Learned a lot. Thank you.

Panel 1: Example feedback comments from individual students

3.3 Clinical Anatomy Suite (CAS)

The Clinical Anatomy Suite (CAS) has been visited by academic staff from the following institutions:

- University of Swansea
- Brighton and Sussex Medical School
- University of Southampton
- University of Warwick
- Royal College of Surgeons of Ireland
- Severn Postgraduate School of Surgery
- University of Odessa

This interest from a diverse range of institutions and constituencies and our continuing links with them is encouraging for the potential wider adoption of CAS techniques by others teaching medicine and health-related disciplines.

The BrainTower functional neuroanatomy model system connected with the Clinical Anatomy Suite has received European Design Registration and discussions are ongoing about how best to make this innovation available to other users.

Operating tables: these innovative and custom-designed tables have been subject to external interest from other institutions. Partly as a result of this, the company commissioned to build the tables are in the process of bringing them to market and developing a promotional brochure describing their functionality.

The Clinical Anatomy Suite has also augmented our potential for providing specialist anatomy courses to external undergraduate students and this area of activity is expected to grow. Currently, the facilities associated with the Clinical Anatomy Suite are being used for the following external undergraduate teaching: Basic Applied Science students (University of the West of England; UWE), chiropractor students (University of Glamorgan), medical students (Peninsula Medical School and others), Musculo-skeletal Science students (City of Bristol College), occupational therapy students (UWE), physiotherapy students (UWE), radiography

students (UWE). One of the radiography students said: '*I felt the whole session was extremely useful as a means of re-inforcing the anatomy knowledge that I have gained over the last two months*.'

3.4 Human Patient Simulators (HPS)

The Human Patient Simulator Teaching Suites have been visited by academic staff from the following institutions:

- University of the West of England
- University of Warwick
- University of Utrecht, Holland

We are also in discussion with staff from the University of the West of England and the University of Manchester about their potential use of AIMS HPS teaching space & equipment and/or teaching materials to support their undergraduate and specialist nursing educational programmes.

Outcomes from this project have also been disseminated both nationally and internationally at conferences and through the scientific & medical education literature. Well-received posters, talks and demonstrations of the HPS have been presented at meetings of the Physiological Society, the Association for the Study of Medical Education (ASME), the Association for Medical Education in Europe (AMEE) and the annual 'Breaking Boundaries' meeting of the Higher Education Academy Subject Centre for Medicine, Dentistry and Veterinary Medicine. Articles describing the ways in which we are integrating the Human Patient Simulators with medical science teaching have been published in 'Physiology News' (the quarterly magazine published by the Physiological Society) and '01' (the quarterly newsletter published by the Higher Education Academy Subject Centre for Medicine, Dentistry and Veterinary Medicine) (see **Annex 3** for further details). An indication of the interest that has been generated by this strand of AIMS is that Dr Harris is an invited speaker at a half-day plenary session on 'The basic sciences and medical education' at the AMEE 2007 meeting in Norway this August.

3.5 Virtual Microscope (VM)

Professor Eddie Odell from Guy's, King's College and St Thomas' School of Medicine, Dentistry and Biomedical Sciences has visited Bristol to look at the Virtual Microscope in action. He wishes to use the system and has suggested to Dr Sengupta that she use her tutorials to generate income for AIMS. Dr Sengupta has also advised the organiser of a pathology unit in Holland about developing and using the VM. Dr Langton has conducted a worldwide survey of current trends and drivers in histology teaching and the impact of information technology on histology learning, teaching and assessment, the results of which should be published shortly.

3.6 External continuing professional development

The Comparative Morphology Centre that operates within the AIMS CETL umbrella has continued to attract CPD courses, predominantly for surgeons (some 10–12 over the last year). The courses are approved by the Royal College of Surgeons and are designed to develop detailed anatomical knowledge, or to develop specialist skills related to particular surgical procedures, or use of particular instruments, or biomaterials. Bristol is a popular venue for the courses because of the excellent facilities for anatomy teaching, now further enhanced by the CAS.

Examples of courses run within the CMC are as follows:

International Spine Association vertebroplasty course

Royal College of Surgeons reconstructive surgery course

Royal College of Surgeons spinal microsurgery course (piloted in 2007)

Royal College of Surgeons scientific basis of surgical practice course

Biomaterials and vertoplasty for orthopaedic surgeons course (sponsored by Orthovita)

International Spine Intervention Society European Advanced Lumbar Workshop

3.7 Interactions with other CETLs, the HEA, learned societies and professional bodies

The CETL initiative has greatly strengthened interactions between the School of Medical Sciences and the School of Chemistry. The two CETLs are the primary focus for this co-operation, which includes regular formal meetings (there is reciprocal representation on the management committees of both CETLs) as well as informal meetings to discuss teaching developments and shared outreach activities. The latter include school visits and use of the Mobile Teaching Unit. The physical proximity of the two Schools enabled us to submit a joint bid to HEFCE that included the creation of shared social and outreach space that is contiguous to the two Schools. Current refurbishments, funded jointly by the university and HEFCE, are enabling AIMS and the School of Medical Sciences to create high quality tutorial/seminar teaching facilities in space that was previously part of the School of Chemistry.

Both Bristol CETLs belong to the South West CETL Cluster, a regional group of CETLs that represent a wide range of subject areas and interests. Meetings of the Cluster are especially beneficial for discussion of generic CETL issues such as evaluation, educational research and dissemination.

AIMS enjoys a good relationship with the Higher Education Academy Subject Centre for Medicine, Dentistry and Veterinary Medicine — the Deputy Director is a member of our Advisory Group and we have contributed to conferences and newsletters produced by the Subject Centre. AIMS representatives have also attended meetings and workshops on educational research and evaluation organized by the Higher Education Academy.

There are close links between AIMS and the relevant learned societies, for example the Physiological Society and the British Pharmacological Society. CETL initiatives have been disseminated through both Societies and Drs Judy Harris and Richard Helyer are the current co-convenors for the Physiological Society Teaching Special Interest Group. This provides an excellent platform for interactions between AIMS and the national and international physiology higher education community.

The AIMS CETL continues to benefit from its connections with the Royal College of Surgeons. One of the Co-Directors (Dr Richard Greene) serves on the Faculty of the College as a Course Tutor and Examiner for the Scientific Basis of Surgical Practice (SBSP) Course. Several other AIMS CETL staff (Drs Harris, Lloyd, Roberts, Wakerley) have contributed to SBSP courses run at Bristol. This association has helped attract other College-approved CPD courses to Bristol. It has also meant that we are well-placed for keeping abreast of, and inputting to, the ongoing debate about the role of Anatomy in undergraduate and postgraduate medical education in the UK. For example, in March 2007 Dr Greene participated in a conference at the College on the

future of Anatomy in medical education, and gave a talk on setting up a regional anatomy centre in which the new Clinical Anatomy Suite was show-cased. Dr Roberts has also contributed to the debate on anatomy teaching within the medical curriculum through a co-authored paper (with Dr A.M. Lockwood) on "The anatomy demonstrator of the future: an examination of the role of the medically qualified anatomy demonstrator in the context of tomorrow's doctors and modernizing medical careers" published in Clinical Anatomy.

3.8 Outreach, widening participation and public engagement with science

There are several strands of AIMS outreach activity which broadly include:

- Expanding the range of external courses — for undergraduates in other institutions and for postgraduates
- Increasing and enhancing widening participation
- Public engagement with science

3.8.1 Expanding external courses for undergraduates

A Human Anatomy Refresher Course was run as a summer school for non University of Bristol medical students: once in July 2005 for 40 students; twice in July 2006 for a total of 24 students and again in July 2007, for 23 students. Feedback from participants has been universally excellent. For example, on a scale of 1 (poor) to 6 (excellent), a quick analysis suggests the following overall scores were obtained:

Administration	4.5
Environment	5.7
Demonstrators	5.5
Resources	5.6
General	5.5

Samples of comments are:

"Level of knowledge of demonstrators was absolutely excellent."

"An excellent course and money well spent"

"Excellent teaching and facilities"

"Really relevant for my stage of learning"

3.8.2 Increasing and enhancing widening participation

The Faculty of Medical and Veterinary Science's Widening Participation Strategy identified schools' outreach as a key area in which to concentrate widening participation activities. What follows are details of new initiatives; in parallel we have continued involvement with existing projects such as the NAGTY and Sutton Trust summer schools and the Brightside Trust which involves medical students as e-mentors.

Schools initiatives

School visits from University academic staff were previously arranged on an *ad hoc* basis; a key CETL aim is to formalise school visits to achieve more systematic coverage and this is now occurring. For 2005–06, a leaflet was published and circulated, containing details of talks from academic staff across the medical faculties. This was very successful and is now being extended

across the University, with production of a 'schools prospectus' for 2006–07. The University Widening Participation office logs numbers of talks and re-invitations, with details of who was involved. We are also gathering feedback from schools and academic staff.

In addition to the visits already mentioned above, Dr Alice Roberts has visited several schools in 2006–07: Glenfrome Primary School (March 2007 — talk on anatomy and health using AIMS CETL and anatomical models); Rednock School (April 2007 — opening science fair); Christchurch Primary School (April 2007 — talk on anatomy and health as above). Dr Roberts also ran a medical sciences / careers in medicine stall at the *Science Alive!* festival in 2006, in conjunction with 60 medical student volunteers.

Other visits include:

Dr Roberts, as Faculty Widening Participation Officer, has also set up a popular partnership with local schools, 'Access to Bristol', in which academically able Year 12 pupils from low income families or low participation neighbourhoods visit the university for 8 half-day sessions throughout the academic year. In 2006–07 a series of biomedical seminars were provided for 40 year 12–13 students from local schools. Each medical sciences department contributes a half-day workshop as part of the biomedical sciences stream.

Weston Science Enrichment Day — students from schools in Weston-super-Mare visited the CAS for a series of medical workshops led by anatomy demonstrators. Doug Jennings, the University's Outreach and Summer Schools Officer, said: '*The medical sciences session was flagged up as a highlight by the majority of the students. The opportunity to spend time being taught by professionals in such an amazing facility is an invaluable experience*.'

As a joint AIMS / Bristol ChemLabS project to support schools outreach, Dr Alice Roberts and Dr Tim Harrison secured additional funding through a successful bid to the University's Widening Participation Initiative fund, for five pilot MTU trips to schools / science fairs. In addition, the University has agreed to fund trips involving the MTU in future (through covering the costs of petrol and driver).

As can be seen from the section above about impact on the wider education community, the Mobile Teaching Unit (MTU) provides a great platform for outreach activities: a lorry that expands to turn into a seminar room capable of accommodating groups of 20 students at a time. Inside the lorry, students can engage in hands-on anatomy and physiology demonstrations, while the lorry also supports larger scale chemistry demonstrations. The comments from school visits highlight its potential as a teaching and learning tool.

In addition to use of the Mobile Teaching Unit for schools visits we contribute to WP residential summer schools such as the Higher Education Summer School and events organised by agencies such as the Sutton Trust and the National Association for Gifted and Talented Youth (NAGTY). AIMS facilities such as the Human Patient Simulators are invariably a highlight of these occasions and the feedback below (Figure 6) from 40 Sutton Trust participants shows that their visit to the university increased the likelihood of them continuing to higher education.

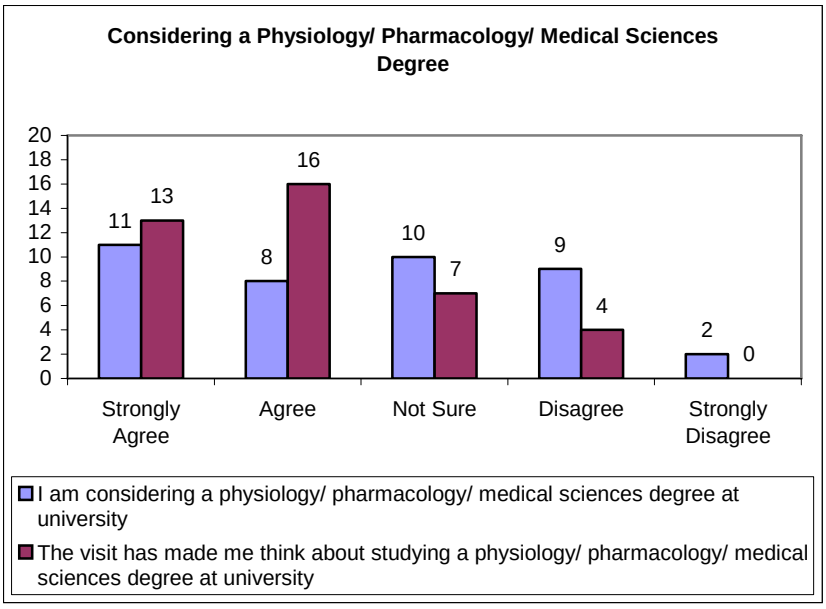

Fig 6. Feedback from 40 Sutton Trust Summer School participants

Attendance at public engagement with science events

Cheltenham Festival of Science

Dr Roberts was invited to join the advisory group for the 2006 festival. In 2007, the MTU was taken to the festival for the 'schools day'; four 'hearts and minds'[11] shows were presented over the course of the day by Anne Cooke, Alice Roberts and Rich Helyer. In 2007 Dr Roberts also joined a panel for a debate about 'Teaching the ethics of science', where the audience included around 150 secondary level science teachers.

'Don't Die Young'

This was a six-part BBC2 series presented by Dr Alice Roberts, with Dr Eugene Lloyd as physiology / medical consultant. Three million viewers watched the series; the Audience Index (indicating audience satisfaction) was 83 out of 100. We have received excellent feedback from public and academic colleagues and the series is now being sold to Australia. Dr Roberts has published a book to accompany the series — *Don't Die Young* (Bloomsbury), which includes the AIMS CETL website reference.

In addition to use of the Mobile Teaching Unit for schools visits we contribute to WP residential summer schools such as the Higher Education Summer School and events organised by agencies such as the Sutton Trust and the National Association for Gifted and Talented Youth (NAGTY). AIMS facilities such as the Human Patient Simulators are invariably a highlight of these occasions and the feedback below (Figure 6) from 40 Sutton Trust participants shows that their visit to the university increased the likelihood of them continuing to higher education.

[11] A poster for the 'hearts and minds' sessions can be found at: http://www.bris.ac.uk/cetl/aims/home_pages/news_html/#Cheltenham

4. Internal strategic impact, including staff continuing professional development

4.1 Promoting interdisciplinary co-operation

Many of the AIMS initiatives are interdisciplinary and this is providing considerable scope for sharing ideas and good practice within the CETL amongst academic and support staff across five subject areas and two faculties. For example, the academic staff who gave talks, led discussions or chaired sessions at the Intercalators' Conference were drawn from Anatomy, Physiology, Pharmacology and Clinical Medicine whilst research talks by the student participants spanned topics from molecular and cellular biology to holistic patient care. This provided all participants with exposure to a wide range of subject areas and approaches.

Development of the Virtual Microscope is involving collaborations between anatomists, physiologists and dentists together with support staff input from histology technicians and IT specialists. Within the university, interest in accessing the VM has recently been expressed by histopathology colleagues in one of our local teaching hospitals and by veterinary pathologists in the School of Clinical Veterinary Sciences.

The Mobile Teaching Unit and our other outreach activities have also enabled us to develop mutually beneficial links with Bristol ChemLabS. As well as joint visits to schools, these links are providing valuable opportunities for staff continuing professional development. For example Lauren Hughes, an AIMS Teaching Fellow, has benefited from attending university summer schools delivered by the Bristol ChemLabS Schoolteacher Fellow, Tim Harrison. The Human Patient Simulator Suites also hosted one component of an Engineering Summer School for Visually Impaired Persons that was organised by the School of Chemistry. The 2-hr interactive physiology teaching session was provided for groups of 5–6 mature adults with very limited vision[12]. The teachers (Judy Harris, Lauren Hughes and Peter Dickens, Senior HPS technician) found it an intensely challenging but personally rewarding experience that required a very different approach from delivering conventional teaching for sighted undergraduates. It was therefore heartening to receive the following feedback from the Summer School Director:

> *"The sessions with you were very well received indeed...I'm sure you gathered that from the questions and responses. There was tremendous enthusiasm for finding out more about the human body: I think you revealed a huge gap in blind people's education and people were fascinated by your presentation".*

AIMS participated in the annual University Learning and Teaching Exhibition in 2005 and 2006, and the university Education Support Unit has offered to host a joint internal conference for the two Bristol CETLs to disseminate their evolving teaching initiatives.

4.2 Participation

When AIMS was created in April 2005, a relatively small group of 'core' staff was identified to lead the various projects. All these staff are still fully involved in leading the projects but many more academic staff (from relatively junior to very senior levels), medical demonstrators and a wide range of support staff are now also involved in developing, supporting and delivering the teaching initiatives. The technical support staff in all our teaching laboratories and dissection rooms, in particular, are fully engaged in supporting the various initiatives in practical teaching

[12] Biomedical Engineering: bodies real and simulated; see http://www.bris.ac.uk/cetl/aims/home_pages/news_html

and provide invaluable input to the developments. Such participation is vital if the CETL initiatives are to become embedded within existing teaching.

5. Lessons learned so far (including unintended consequences)

5.1 Lessons learned

Whilst we have made very good progress with many of the AIMS projects, we have also encountered some set-backs which have resulted in less progress than we would have wished. One example is the virtual veterinary dissection project (also called "virtual dog" project), which was intended to create an anatomically accurate 3-D dog model, based both on body slices preserved between perspex sheets, and a computer simulation containing rotating 3-D images. The staff member undertaking the project (Dr Wakley) decided to use his fellowship to learn complex 3-D simulation software of the type used in film, animations (he has undertaken a course during his fellowship). Application of this software to develop anatomical simulations has proved very challenging and in hindsight it would have been more productive if the project had focussed on producing the dog sections and using these for producing the virtual simulations, as was the original plan. The CETL management has learnt from this experience, and there will be much closer monitoring of the strategy for future projects of this type. Thus a similar project (Dr Sengupta: Development of 3-D facial reconstructions for understanding facial surgery) has been reviewed by the whole management group prior to the start of the fellowship. It will involve defined intermediate goals, including an appropriate amount of low-risk work that is guaranteed to be productive, as well as the more ambitious components.

Whilst developing the initiatives within the first two years of the CETL has been enormously rewarding and productive, our original bid underestimated the additional workload that would fall to the AIMS senior management team. Both of the AIMS Directors have extensive other commitments both within, and outside, the university so we have decided to strengthen the senior management team by appointing a 0.5FTE AIMS manager. As well as supporting the Directors in areas such as finance, recruitment, evaluation, dissemination and business development, the manager will make an important contribution to maintaining and reinforcing coherence between the various strands of the CETL. The interdisciplinary nature of AIMS is challenging, as well as stimulating, and it is important that we maintain excellent lines of communication within the CETL. As mentioned elsewhere, we have already made an excellent internal appointment to this post.

Development of the AIMS CETL projects has involved considerable extra workload for the departments involved. Whilst this has had most impact on those directly responsible for the projects, it has also impinged (in some form or another) upon many other teaching staff. For example, the provision of teaching fellowships has necessitated re-organising and/or re-assigning teaching duties, and despite the additional funding coming into the departments via CETL, there is a perception that teaching loads have increased.

Regarding the impact of AIMS CETL on the student body, it has been an unfortunate co-incidence that over the last 1–2 years there has been a decline in the provision of small group teaching on the MBChB programme. This decline has arisen mainly because teaching income has not kept pace with expansion in student numbers. There is no doubt that initiatives created within the AIMS CETL (for example, the HPS and CAS), have helped to offset the negative effects on students of diminishing small group teaching, which has inevitably caused concern among some

students. There has been a tendency, however, for some students to link the reduction in small group teaching to the AIMS CETL in a negative way, rather than seeing the CETL as having a positive influence on a situation that would have occurred anyway. The AIMS CETL management group are aware of these perceptions, and the need for internal as well as external dissemination of the AIMS CETL achievements and its benefits to the student learning experience. Meetings have already been held between AIMS CETL staff and student representatives to discuss some of the students' concerns and these will continue regularly to ensure that all students are aware of the benefits offered by the AIMS CETL teaching and learning initiatives.

5.2 Unintended consequences

As a result of the CETL funding to develop the Virtual Microscope, we have been able to equip our histology class laboratory with 68 networked, small foot-print PCs. This facility, together with the excellent CETL-funded AVA facilities that we have also been able to install, provides a good venue for hosting computer-based assessments for medium-sized cohorts of students. This usage of the laboratory had not been anticipated at the outset of the CETL but it has already hosted three computer-based assessments for other university departments and interest in the venue is growing. With increasing student numbers, computer-based assessment is becoming more common. We are hoping that, by making the space and IT equipment available for assessment when it is not needed for teaching, we may generate some income for AIMS, as well as provide a much-needed university facility.

The strong relationship that has developed between the two Bristol CETLs, mentioned elsewhere in this report, was perhaps not unexpected but it has certainly resulted in collaborations that had not been anticipated when the original bids were made to HEFCE. The links are particularly strong in terms of outreach with schools but they are also developing in other areas. For example, several medical science departments are exploring the possibility of adopting some aspects of the Bristol ChemLabS Dynamic Laboratory Manual and the Physiology Department is now using pre-practical assessments, partly as a result of discussions between Bristol ChemLabS and AIMS staff.

Another unexpected outcome has been the dramatic impact of the Human Patient Simulator teaching in terms of student feedback across all our degree programmes. Most students express a marked preference for HPS-based teaching compared with other forms of learning and teaching. Whilst this is very rewarding, it poses some challenges in managing student expectations as small group teaching is very labour-intensive. We are now able to broadcast video footage of the manikin and the physiology display panel from our HPS Teaching Suites (which accommodate up to 20 students) into the adjacent Teaching Laboratories (which accommodate up to 120 students). We hope to develop more teaching scenarios that can be used for large group teaching so that use of the HPS can be increased without placing unrealistic demands on staff time.

In circulating medical schools to send delegates to the Intercalators' conference, several staff expressed an interest in attending the Conference themselves. Feedback comments from students indicated they would prefer more staff to be present. For next year we are planning on inviting staff representatives with particular responsibilities for intercalation at the various medical schools to attend the Conference. It is anticipated that this will provide a valuable opportunity for discussing and comparing notes about intercalation at staff, as well as student, level.

6. Summary for AIMS

In relation to the objectives of the CETL listed in section 1.1, we feel we have presented evidence that AIMS is making very good progress in '*establishing first-class educational facilities'* and *'developing a range of innovative approaches to medical sciences teaching and learning'* which are becoming *'embedded within the existing curriculum'*. Information about the AIMS Centre is being disseminated to a *'wide range of stakeholders'* and the facilities within the CETL are enriching learning and teaching, not only for University of Bristol undergraduates, but also for schoolchildren (various references in section 3), undergraduates from other HEIs (3.2 and 3.8.1), postgraduate health professionals (3.1, 3.3, 3.4) and the general public (4.1). We are particularly keen to develop and expand potential contacts with other HEIs (3.3–3.5, 3.7).

We now have clear evidence (e.g. Figs 1–5) that undergraduates find the evolving AIMS initiatives engaging and valuable for their learning. There is no evidence that student achievement has fallen (2.2, 2.3), despite some major (but inevitable) changes in the way that some of our teaching is now delivered. Longer term benefits for student achievement and recruitment will take some time to evaluate but we are conducting longitudinal cohort analysis in order to assess this.

We are developing a number of *'educational and discipline-based research'* activities and, as shown in **Annex 3**, the results are already being disseminated through the scientific and medical education literature.

The AIMS facilities have already resulted in some '*efficiencies in the use of resources for teaching and learning'* in developing self-directed learning in anatomy (see Introduction, section 3.3.1), and we anticipate that further development of the Virtual Microscope and associated teaching materials will have similar benefits for histology.

In terms of sustainability, we are beginning to expand our portfolio of income-generating external courses (Introduction, section 3.3; AIMS self-evaluation, sections 3.5–3.7), and we are working closely with the University Campaigns and Alumni Office to explore other fund-raising approaches. We are aware that this is an area that we need to address more fully in the future.

SECTION 3: CHEMLABS — Self-Evaluation

1. Background to the self-evaluation

1.1 Aims and objectives

Bristol ChemLabS is one of relatively few CETLs that are focussed on aspects of teaching and learning in science and the only CETL project devoted entirely to chemistry. The initial aim of the Bristol ChemLabS project was to raise standards in practical chemistry in higher education through the creation of a national resource for the teaching and learning of practical experimental science. It was, however, envisaged even at this early stage that the outcomes would also have consequences for other scientific subjects and other age groups. This aim was to be achieved by developing state-of-the-art refurbished teaching laboratories, equipped with research-grade instrumentation and by creating innovative new skills-based practical courses that made use of the latest e-learning technology and revised teaching and assessment methods. The CETL would also aim to engage and enthuse students of all ages through a programme of outreach and public-engagement activities, facilitated in part by the appointment of a School Teacher Fellow.

1.2 Overview of CETL activities

The first two years of the Bristol ChemLabS project have already seen considerable and demonstrable achievements. Refurbishment of the undergraduate teaching laboratories is now complete with the first phase of equipment and computers installed. Two cohorts of students, those in Level 1 and Level 2, have been using the laboratories for their scheduled practical classes; Level-3 students will start using the facilities in the next academic year. The new teaching, learning and assessment methods are now in place. There is now a much stronger emphasis on proper pre-laboratory preparation, with students having access to supporting material, as well as summative and formative assessments, to support their preparation. Most assessment now takes place within the laboratory, with demonstrators and staff able to give feedback directly to students. Some of the pre-laboratory material has already been incorporated into an interactive web-based Dynamic Laboratory Manual, which has been developed in collaboration with a local company, LearningScience Ltd. The on-line Dynamic Laboratory Manual is now in use by Level-1 students and will become available for Level-2 students in October 2007; a version for Level 3 will follow in October 2008.

Fuller details of our activities are given in the Bristol ChemLabS Annual Reports[13] .

1.3 Management structure

The activities of the CETL are overseen by an executive team that consists of a Bristol ChemLabS Chief Executive, Director and Manager. This team works closely with the Head of the School of Chemistry, as well as senior members of staff responsible for overseeing the School's capital projects and administration. Other members of the Bristol ChemLabS team with significant responsibility for helping to achieve the aims and objectives include the Outreach Director, the School and University Teacher Fellows and the Teaching Laboratory Managers. Administrative support for all Bristol ChemlabS activities is provided by a full time secretarial appointment. Members of the wider team meet informally on an almost daily basis to review

[13] Bristol ChemLabS Annual Reports: http://www.chemlabs.bris.ac.uk/Documents/

progress and developments. There are also formal quarterly meetings of the Bristol ChemLabS Management Board. Its membership is diverse and includes representation from University of Bristol staff outside the School of Chemistry who have an interest in and responsibility for maintaining and improving standards in teaching and learning, as well as a member of the Higher Education Academy Physical Sciences Subject Centre. Undergraduate and postgraduate students are also represented on the Management Board. The Bristol ChemLabS Advisory Board meets annually. The Advisory Board is chaired by the University's Pro-Vice Chancellor for Education and, as well as including all of the members of the Management Board, also includes representatives of the key external stakeholder groups. Evaluation is a standing item on the agendas of both the Management and Advisory Board meetings.

2. Student experiences, including effects on teaching methodology, space and learning designs

2.1 Impact on learning and teaching strategies

The original aims and objectives of the Bristol ChemLabS project centred upon developing a new strategy for teaching and learning in practical chemistry. The new Level-1 and Level-2 practical elements have only been in operation for a couple of months and it is perhaps too early to make a proper assessment of the impact of the changes on student achievement. Consideration of the average marks obtained by students so far, does, however, suggest a significant improvement over the level of achievement in previous years. Whilst it is tempting to attribute this change solely to the introduction of the new teaching and learning methods, a number of other factors such as a revised timetable, may also have made a contribution. A rigorous evaluation will therefore not be performed until the end of the next academic year, as only then will truly comparable data will be available. This analysis will help to inform further developments of teaching and learning strategy.

School Teacher Fellowship

As mentioned in the Introduction, an important part of our project is the role of the School Teacher Fellow. In the initial bid it was envisaged that, although the School Teacher Fellow would have particular responsibility for developing the School of Chemistry's existing programme of outreach and public engagement activities, s/he would be able to contribute to many other aspects of the Bristol ChemLabS project, from curriculum development to dissemination.

Whilst at the outset we expected the recruitment of a School Teacher Fellow to have a significant impact on the scope and effectiveness of these activities, even we have been taken aback by the success of the appointment. Our programme of outreach activities is now heavily over subscribed to the point where we are unable to cope with the demand for the events that we offer. We typically engage with several hundred (and sometimes several thousand) primary or secondary students every week, either through events held within the School of Chemistry, or by visits to schools and colleges across the region and further afield.

The success of the fellowship is undoubtedly due both to the concept of appointing a school teacher to work in a university department and to the personal qualities of the particular teacher appointed. Our School Teacher Fellow, Tim Harrison has many years of experience in teaching in a variety of different secondary schools and is a superb communicator. Feedback from the primary and secondary students with whom he works shows the impact of Tim's activities. He

has the respect of teachers in both the primary and secondary sectors, as well as academics in higher education. He is therefore in an ideal position to inform each group about the challenges and developments within the other sectors. He is also able to engage with our own undergraduate and postgraduate students, inspiring many of them to participate in the Undergraduate Ambassadors and Science and Engineering Ambassadors Schemes.
The model has been adopted by other organisations, both in the field of Chemistry and in other subject areas. The Royal Society of Chemistry has, for example, recently recruited a number of School Teacher Fellows to work in universities across the country as part of its Chemistry for our Future initiative. Our experience has been invaluable in planning this aspect of the initiative, with Tim Harrison assisting in the recruitment and training of the School Teacher Fellows.

2.2 Impact on learning and teaching practice

The impact of the changes on learning and teaching practice are clear, even at this very early stage. Feedback from representatives of the undergraduate and postgraduate focus groups demonstrates that introducing more pre-laboratory preparatory work at the expense of post-laboratory out-of-class assessment has helped to promote student learning significantly and enhance their experience both in and out of the laboratory. The students recognise these benefits, commenting in questionnaires at the end of their practicals

> *"Very well organised this year — pre-lab work was a very good idea."*
>
> *"The labs provided an incentive to read around the subject …"*
>
> *"These labs were so much better than last year, especially when understanding the experiments before coming into the labs"*
>
> *"It has been very, very useful working through the pre-lab material"*

One undergraduate focus-group member commented that she had

> *"done less work, but learned more".*

This was a particularly revealing comment, since the amount of time students should actually spend on the element has remained the same; it is merely the balance between pre- and post-laboratory work that has changed. We had set out to design a practical element that students and staff would enjoy, and where the workload for both groups was not burdensome. It was therefore gratifying to receive feedback such as this.

The experience of the students is confirmed by the comments of members of academic staff who have reported that they are now able to engage with students at a much higher level of understanding than previously.

The initial feedback, whilst very encouraging has, of course, not been entirely positive. Most of the negative comments refer to practicalities that are easy to address. However, others show the need to ensure a more uniform standard of demonstrator cover and to reconsider some of the particular forms of assessment and feedback. These more critical responses do demonstrate the usefulness of the evaluation process in revising existing practice and shaping future developments.

2.3 Student experience

Practical work forms a major component of our chemistry degree programmes. Since the restart of the practical element, Level-1 students have spent 3 hours per week and Level-2 students have

spent 12 hours per week in the new laboratories. Furthermore, many of the aims and objectives of the Bristol ChemLabS project relate directly to enhancing the student experience of chemistry. The impact of the new facilities and practices on the experience of students is therefore expected to be significant.

The refurbishment of the teaching laboratory facilities has clearly led to a significant improvement in the students' working environment. Previously, the laboratories were adequate, but rather old fashioned. Now, they are comparable to some of the best research facilities. Environment is, of course, a critical factor in promoting student learning. Many chemistry students come to university with little experience of practical work. They will have spent very little time in the laboratory during their secondary education and will not be familiar with working in such an environment. Furthermore, despite being academically very able, they lack confidence in their practical skills. By providing them with a pleasant and spacious working environment, we intended to help the students feel more comfortable in the laboratory, allowing them to focus on their own learning rather than external factors. The high level of investment in equipment has also had an impact in this respect. Students know that the apparatus they are using will work properly. All too often in the past, students have been disenchanted by having to use old or patched-up pieces of equipment. This is exemplified by comments from both staff and students. For example, it was noticeable how many comments students made in their end-of-course evaluation questionnaires about the quality of the laboratory environment. Some were very constructive and considered:

> *"I enjoy the relaxed atmosphere in the labs and feel that it aids productive work"*
>
> *"Excellent facility to carry out experiments"*
>
> *"Labs are so much better this year, technology is great and they are bright and spacious"*
>
> *"Enjoy the atmosphere and special layout of the lab."*

Others went even further (and perhaps a little bit too far!):

> *"I just wish to stay here and conduct experiments rather than going home for the summer. I'd rather spend my day here than go to lectures or workshops … This place is wonderful."*

Furthermore, at a recent evaluation session held to review the first few months of operation of the new laboratory element, one member of academic staff said that

> *"The standard of the laboratories instils respect in both the process and the equipment".*

There have also been additional benefits to students. The new laboratory elements appear to have helped students in their general understanding of chemistry. Indeed in one questionnaire response, a student commented in particular that performing the experiments and talking to demonstrators had helped them to understand better the concepts covered in lectures. The developments also clearly mean that the students are better motivated. Students commented that

> *"I no longer dreaded labs"*
>
> *"I have really enjoyed being in labs again"*

whilst another said that the practical element was

> *"One of the few occasions during university education where you know your hard work will definitely have good results"*

The response from secondary-school students and teachers who have used the new facilities has been similarly positive. In a report in their newsletter outlining a visit by some Year-11 students to the School of Chemistry, St. Bede's Catholic College, a school in inner-city Bristol, described being able to use the refurbished laboratories as

> *"a unique opportunity to undergo a life-changing experience"*

The experience offered to students during such outreach events is critical in raising aspirations.

The following sub-sections explore in detail the different strands of CETL activity affecting the student experience.

2.3.1 The Intensive laboratory element

The building work associated with the project meant that it would be necessary to close the teaching laboratories for an entire calendar year, with existing Level-1 students taking an intensive two-week laboratory element following their examinations in the summer term to make up for some of the laboratory time they would be missing in the following academic year. This was to be a very different experience for students: previously they had only performed practical work for one afternoon in each week; the end-of-term element would instead see them working in the laboratory for eight whole days during the fortnight. The assessment methods used were also to be different. As a prelude to the methods to be used in the new practical elements that would be introduced after the laboratories had been refurbished, long experimental write ups would be replaced by in-class marking and immediate feedback.

There was already some anecdotal evidence that students find such an intensive laboratory experience very beneficial. This certainly proved to be the case, and the intensive laboratory element has therefore been adopted as a permanent feature of our practical teaching. Feedback from students through focus groups and questionnaires showed that they enjoyed and were motivated by spending a significant amount of time working in the laboratory, free from the distractions of other teaching. The pace of the intensive element meant that they were able to put into use straight away the practical skills they had developed and to reinforce their understanding of practical techniques and instrumentation through their immediate application. The experience also acted as a prelude to the next year's material, giving students an insight into the more demanding experiments to come. Students were excited by this new challenge and so looked forward to the start of the new academic year with renewed enthusiasm.

Students commented that they did find the in-laboratory assessment initially rather daunting, as they had previously been used to submitting written manuscripts for assessment. However, they quickly realised the benefits of such methods in helping them to move beyond simply learning facts to the point where they were now required to understand some more challenging concepts. They were aware that the intensive element had therefore helped them develop into more mature learners.

It will be interesting to evaluate the progress and level of attainment of the current cohort of Level-1 students who will be the first to perform the intensive laboratory element as part of their normal timetable of practical activity.

2.3.2 The Electronic Laboratory Notebook

In the original vision for the new practical element, it had been proposed that an Electronic Laboratory Notebook (ELN) would be created that would allow students to record and share their experimental observations, and analyse and interpret their results. The use of such notebooks is

slowly being adopted in industry and it was initially thought appropriate to try to give undergraduate students experience and practice in using such resources. However, evaluation following consultation with stakeholders on both the DLM and ELN led to a reconsideration of the strategy. It was agreed that the ability to keep a well-ordered, neat hand-written record was an essential attribute for a practicing scientist, even if the environment in which they were working made use of electronic laboratory notebooks. It was realised that the use of an ELN would therefore not provide students with a proper experience of maintaining a scientific record. Furthermore, since the adoption of electronic notebooks in industry was far from universal, training in their use was not a core skill that all graduates should be expected to have developed. The concept of the ELN was therefore revised. It was decided that certain elements of the ELN, such as the ability to analyse spectra and other data using the operating software developed by the instrument manufacturers would instead be incorporated into the DLM, but the ability to record other, more qualitative observations would not be included.

2.3.3 Demonstrator training

The involvement of postgraduate students as demonstrators is crucial to the success of practical teaching in most university science departments. Opportunities for teaching are often valued by postgraduates as a way of developing additional skills and knowledge — it is true to say that until you try to teach someone something, you are not fully aware of what you do and don't know. New undergraduate students are often more willing to approach postgraduate demonstrators than members of academic staff. Postgraduates can easily relate to the problems that undergraduate students have, and so provide an important link between students and staff. We recognised immediately, however, that being an effective demonstrator is not necessarily easy. We therefore appreciated the need for proper training of postgraduate demonstrators. Demonstrators must, of course, understand the chemistry behind the experiments that they are supporting and be familiar and confident with the practical techniques that are used. They must also be able to engage and communicate effectively with undergraduate students. Furthermore, demonstrating in a practical laboratory is probably the first time that many postgraduates have been involved in the assessment of other students, and training is required to ensure that marking is both uniform and fair.

The first few months of operation of the new laboratory elements were unusual in that we tried to condense a whole year's experience into just a few months. Although completed on schedule, the refurbishment of the laboratories left little time for demonstrator training. We were keen to ensure that our undergraduate students were able to spend as many of the remaining sessions as possible in the laboratory and therefore needed to compromise between the time allocated for postgraduate demonstrator training and for regular undergraduate teaching.

Feedback from both undergraduate and postgraduate students obtained during the post-mortem sessions on the Level-1 and -2 laboratory elements suggested that we had, under the circumstances, achieved the right balance between postgraduate preparation and undergraduate teaching. However, group discussion also highlighted the need for a more structured approach to demonstrator training, with better guidance on assessment and working with students. We are confident that such training will be of significant benefit to both postgraduates and undergraduates. The forthcoming introduction of a demonstrator version of the Dynamic

Laboratory Manual will obviously also help in preparing postgraduates for the teaching that they do in practical classes.

3. Connections with and effects on external partners and the wider education community

3.1 Sector-wide effects

In developing our dissemination strategy, we decided that initially we would not publicise our activities too widely, preferring to be able to demonstrate actual achievement and innovation rather than just promise. We did not want to dilute the impact of the project. Nevertheless, even in the very early stages of the project, we have received considerable interest in our activities from other Chemistry departments in the UK and across the rest of Europe. We have, for example, already engaged with academics from the Universities of Manchester and Oxford as well as Imperial College, London, to discuss how the developments that we have put in place may be incorporated into the redevelopment of their own undergraduate practical chemistry elements.

There has also been considerable interest from academics working in other subject areas. Many of our innovations, such as the development of the Dynamic Laboratory Manual and the move to more in-laboratory assessment are applicable in subject areas other than chemistry. We are currently working with a number of other departments across the Science and Medical Science Faculties at the University of Bristol who are keen to implement some of the developments in their own teaching. We anticipate that these cross-subject collaborations will grow as we begin to disseminate more widely outside the Chemistry community.

3.2 CETLs, the HEA and other professional bodies

Bristol ChemLabS has very good links with other CETLs, the HEA and professional bodies. The Bristol ChemLabS team works closely with staff from the other Bristol University hosted CETL, AIMS. Although the two CETLs focus on different subject areas, both involve the development of innovations in the teaching and learning of practical science. The close geographical proximity of the two CETLs on the University of Bristol precinct has also helped in building a strong relationship. The two CETLs put in a combined bid for additional capital funding from HEFCE, and this has been used to finance a joint Bristol ChemLabS–AIMS lorry for outreach work, as well as providing some shared social space for visiting school groups and for other activities.

Bristol ChemLabS has also been working with the CELS CETL at Nottingham Trent University. Both CETLs have a strong focus on educational outreach and have appointed school teacher fellows to help coordinate and run engagement activities. The two CETL teams meet regularly to discuss developments and share good practice.

Bristol ChemLabS, along with AIMS, is a member of the SouthWest CETL Cluster, a regional group of CETLs representing very different subject areas. Membership of this informal grouping has benefited Bristol ChemLabS in a number of ways. Following a workshop at a recent meeting that centred on the theme of educational research, we are also now exploring possible collaborations with the CETL in Experiential Learning in Natural and Environmental Sciences at the University of Plymouth. It has also been interesting to learn of the approach adopted by other CETLs to the evaluation process.

We also have a good relationship with the Physical Sciences Subject Centre of the Higher Education Academy. The Centre is represented on our Management Board, and we have participated in a number of events run by the HEA to help in disseminating news of the developments of our and other science CETLs.

Our links with the Royal Society of Chemistry (RSC) are also strong. Indeed, Bristol ChemLabS is a leading partner in the RSC's Chemistry for our Future project, which is part of HEFCE's initiative to support strategically important, yet vulnerable subjects. The RSC is represented on the Bristol ChemLabS Advisory Board and has made a significant contribution to dissemination.

3.3 Outreach and public engagement

Outreach and public engagement activities form an important and remarkably successful part of the Bristol ChemLabS project. In the first two years of the Bristol ChemLabS CETL, we have engaged with many thousands of participants across all age groups and levels of experience. The elements of the outreach programme may be divided into: activities for primary school pupils; aspirational activities for secondary students intended to promote participation in tertiary-level science; curriculum-based activities to support teaching and learning in secondary schools and colleges across the wider south-west region; continuing professional development for teachers; public engagement. Many of these activities take place within the refurbished laboratories at the School of Chemistry, although other events, most notably those for primary schools, do take place away from the University of Bristol.

Evaluation of outreach activities is notoriously difficult. We have therefore been careful to include strategies for assessment of the short-, medium- and long-term impact of our outreach programme within the evaluation framework and have been collecting both qualitative and quantitative evidence on the effectiveness of each type of activity.

The comments from participants involved in our activities for primary schools are typical, although we could have chosen to illustrate this section with similar feedback from each of our other types of event. For example, after assembly conducted by Tim Harrison, the Bristol ChemLabS School Teacher Fellow, one year-6 pupil at St. Mary's Church of England Primary School, Thornbury, wrote:

> *"Before you came in I absolutely hated science, but you have inspired me to like science loads now, so thank you."*

Another gave an interesting perspective on the primary-science curriculum, writing:

> *"I used to think science was boring because of all the fair test, but now I have an entirely different view."*

Their views are supported by comments from teachers. Maggie Cosgrove of Henleaze Junior School, Bristol commented:

> *"The assembly was stunning — I have never witnessed such spontaneous applause in our hall and the playground was buzzing with children's comments for days afterwards. It was wonderful to see the children experience some of the awe and wonder of science."*

Annabel Glassby, a year-5 teacher and science coordinator at Hillcrest Primary School, Bristol pointed to the effectiveness of the Bristol ChemLabS Chem@rt project in raising levels of attainment:

"This is a really innovative approach to encouraging children to relate to the science curriculum. We have been very successful in our SATs results this year due to this approach. It will have enormous benefits to the children."

The effectiveness of such interventions has also been noticed by parents. Lynne Banks, a year-6 teacher at Winchcombe Primary School, Bristol was told by the parent of one very able boy, that when she had asked her son about his future ambitions and whether he still wanted to be a footballer, his reply was:

"No, I don't think so. I think I might be a research scientist now."

4. Internal strategic impact, including staff continuing professional development

4.1 Raising the status of practical chemistry

Members of staff within the School of Chemistry have long recognised the value of engaging with students in helping to develop their practical skills in particular and their knowledge and understanding of chemistry in general. However, academic staff involvement in laboratory demonstrating is a time-consuming activity and balancing the sometimes conflicting demands of intensive teaching and research presents all Chemistry departments with a considerable challenge. The considerable investment in the refurbishment of the undergraduate teaching laboratory facilities and the development of innovative new teaching methods has revitalised our practicals. This in turn has had a significant impact on the status of undergraduate teaching within the School, with both staff and students committed to the aims and objectives of the Bristol ChemLabS project. There is therefore a renewed willingness by staff to devote time to practical demonstrating. This is exemplified by the involvement of the Head of School and the heads of each of the individual sub sections to demonstrate in the undergraduate laboratories. Whilst this outcome was not unexpected, it is gratifying to see just how successful the Bristol ChemLabS project has been in this respect.

4.2 Participation

The development and implementation of the Bristol ChemLabS project involves just about every student and member of staff in the School of Chemistry. The new facilities and practicals have had a significant impact on our undergraduate students, since practical chemistry forms such a major component of our degree programmes. Postgraduate research students have, however, also been involved as demonstrators and through their contribution to outreach work. Members of academic staff have contributed at many levels: just about every member of academic staff has engaged in demonstrating within the new practical laboratories and many have contributed through the development of new experiments. The roles played by the technical staff within the teaching laboratories have also been crucial. In addition, the support from other technical and administrative staff has been very valuable in ensuring the success of the project. Others from outside the School of Chemistry also have significant roles to play, whether as members of the project team working on the building project, through membership of the Management or Advisory Boards, as collaborators in outreach or research activities, or as informal advisors.

The willingness of members of the School of Chemistry to engage wholeheartedly with the Bristol ChemLabS project is undoubtedly one of the reasons why we have been able to achieve so much in such a short time. Undergraduate students have suffered considerable upheaval because the closure of the teaching laboratories necessitated the rearrangement of their teaching

timetable. Postgraduate students have also been very supportive in undergoing their programme of demonstrator training, in spite of the very short time available for preparation. The technical and administrative staff have responded magnificently to the increased workload and short deadlines that a project of this magnitude creates. The Bristol ChemLabS project has generated enthusiasm across the whole School of Chemistry and the energy and motivation that it has created have transferred into other areas of activity.

We have tried hard at each stage to ensure that the contribution of each of these groups of participants has been recognised. All too often in universities, non-academic staff feel that their input is ignored and we wanted to demonstrate, at least informally, that we recognised and appreciated their contribution. We have therefore held a number of social gatherings that have brought together staff and students from within the School of Chemistry and the wider University. We have also tried to involve everyone in the evaluation process. This is critical not only for the information that it provides in helping to develop the project further, but also in recognising more formally the value that we place on everyone's contribution. The Evaluation Framework, which is described later in this report, outlines how we have tried to involve all of these participants in that process.

5. Lessons learned so far (including unintended consequences) and actions to be taken in response

5.1 Unintended consequences

5.1.1 The use of e-Learning within other units and elements

The extensive use of e-learning methods in the new laboratory practicals has helped in promoting the innovative use of information technology for many other School of Chemistry units and elements. Most members of staff already placed copies of their lecture presentations or notes on the internet using the University of Bristol's virtual learning environment (VLE), Blackboard. However, few made use of some of the VLE's more advanced features, such as the ability to produce formative self tests. With the development of the DLM, members of staff became aware of the additional features available from a VLE. As a result, sets of formative on-line pre-workshop questions have now been developed for many Level-2 and Level-3 units and elements. These questions allow students to test their knowledge of the lecture material and develop an understanding of some of the more elementary concepts ahead of a workshop. Staff can then focus on the more difficult material or concepts during the sessions themselves, knowing that students will be properly prepared. This use of e-learning to support students in their self study and so make more efficient use of staff contact time is one of the key innovations in the Bristol ChemLabS project, and it has been encouraging to see it being adopted in other areas of teaching.

5.1.2 Development of the Dynamic Laboratory Manual for use by schools

In developing the Dynamic Laboratory Manual for use by our own undergraduate students, we became aware of the possibilities for exploiting the concept in secondary education. We quickly recognised that a Dynamic Laboratory Manual for schools offered significant benefits to students performing their practical work in their own facilities as well as those who might be using university laboratories as part of an outreach programme. The Dynamic Laboratory Manual is intended to ensure that students are thoroughly prepared before they enter the laboratory, so that they can make the most of their practical classes. The DLM engages and enthuses students,

providing an active mechanism for either independent or directed self study. These principles apply equally well to secondary as to tertiary education. Support for the production of a secondary-school DLM has come from both students and teachers, as well as representatives of the major examination boards. Whilst we would not want the expansion of the DLM project into secondary education to divert our attention from achieving our aims and objectives in higher education, we do see possibilities for generating an income stream that will help in sustaining investment in the Bristol ChemLabS project after the end of HEFCE funding.

5.2 Reflections on the Idea of a CETL as a change strategy

One of the key aspects of the Bristol ChemLabS project is the refurbishment of the School of Chemistry's undergraduate laboratories to provide a world-class environment for the teaching of practical chemistry. Whilst it was recognised within the University that such a refurbishment was desirable in order to maintain the School of Chemistry's reputation for excellence in teaching, the high level of capital investment needed meant that the project was not viewed as an urgent priority. It is therefore unlikely that the refurbishment of the laboratories would have proceeded without the CETL programme.

The call for bids for CETL funding provided a focus and incentive for staff within the School of Chemistry to develop a detailed plan for the refurbishment project. The existence of this properly structured, formal plan undoubtedly raised the status of the project within the University. The proposal made clear the need for the refurbishment and demonstrated, in terms of educational and financial benefits, the return that would made on any investment. The plan therefore gave the University sufficient confidence to agree to allocate additional funding to complete the refurbishment should the CETL bid be successful.

5.3 Commercial sponsorship of outreach activities

In developing our programme of outreach and public engagement events we have been conscious of the need to ensure that our activities can be sustained beyond the end of the period of CETL funding. We have therefore investigated a number of ways in which such activities could become self financing. We have therefore approached a number of stakeholders about the possibility of their sponsoring some of our outreach activities. We were initially unsure of whether such a strategy would be successful, since, although there is universal acceptance that such activities are very valuable, many are perceived as having rather intangible or only long-term benefits. We have therefore been pleasantly surprised by the willingness of some stakeholders to support particular outreach activities even though there may not be a direct, short-term benefit to their organisation. We are therefore currently attempting to put together a business plan that will include support from such organisations, as well as other sources, to ensure that our outreach activities can be sustained.

5.4 The challenge of dissemination

Whilst we were very confident that innovations such as the Dynamic Laboratory Manual would have a considerable impact on teaching and learning for undergraduate students at the University of Bristol, implementation of some aspects of the project is technologically rather involved, and our dissemination could involve Bristol ChemLabS staff in a considerable amount of activity in setting up the at the partner institution. We are therefore currently trying to explore ways in which we can disseminate effectively so that the results of the project can be taken up by science departments at other institutions without considerable investment of staff time and other resources on our part.

6. Summary for Bristol ChemLabS

Considerable progress has already been made towards meeting the aim of the Bristol ChemLabS CETL project to raise standards in practical chemistry through the creation of a national resource for the teaching and learning of practical experimental science. The timetable for refurbishment has meant that our undergraduate students have not yet experienced a full academic cycle using the new facilities. We have not therefore yet been able to assess in a quantitative way the impact of the developments on student achievement. However, qualitative feedback indicates that the effects on learning and teaching have been significant.

The refurbishment of our undergraduate laboratories has been completed on schedule and has indeed created a world-class environment for the teaching of practical chemistry. The laboratories are equipped to the very highest standard providing demonstrable benefits to both undergraduate students and staff. The introduction of innovative new teaching methods has also proved highly successful. An on-line web-based Dynamic Laboratory Manual has already been created for level 1 students, allowing the introduction of new methods of assessment and mechanisms for feedback that are both more effective and more efficient.

The impact of the developments in teaching and learning methods within the School of Chemistry has spread beyond just practical courses. The project has raised the status of teaching and learning and led to innovations, such as the greater use of e-learning, in other areas of the curriculum. There has also been considerable interest from other sectors of the higher education community, including from chemistry departments in other universities, and even other subject areas. Furthermore, the concept of a Dynamic Laboratory Manual for schools and colleges has also been well received by those involved in secondary education. In addition, we are now working with external partners to conduct educational research to assess the impact and value of these and other innovations in teaching practical science.

Our programme of outreach activities have proved highly successful, thanks largely to the appointment of an experienced School Teacher Fellow.

We have been active in exploring ways of ensuring that the achievements of the Bristol ChemLabS are sustainable. We have not only been successful in obtaining commercial sponsorship for our activities but have also identified a number of ways, such as production of a Dynamic Laboratory Manual for schools and development of profit-making outreach activities, in order to generate additional revenue.

SECTION 4 — CONCLUSIONS

This self-evaluation summarises some of the emerging developments from CETL activity at Bristol. It shows that there are already changes in the student experience as a result of CETL investment. Internally, these include improvements in learning and achievement and importantly in enjoyment of the subject(s). Externally, early reactions to outreach activity indicate that elements of CETL activity are inspiring students in schools and motivating them to study science at higher levels. However, there have also been some challenges to be addressed, including the consequences of additional workload on some staff.

1. Activities and progress of particular note

1.1 Impact of the CETLs on student achievement and enjoyment of learning

It is clear that both CETLs have already made a difference to student achievement.

(Section 2 AIMS self-evaluation: 2.1–2.3; Section 3 Bristol ChemLabS self-evaluation: 2.3 (including 2.3.1))

In AIMS, the Human Patient Simulator, Clinical Anatomy Suite and Virtual Microscope have already had a positive effect on undergraduate education across a range of programmes and show potential for further development. The Intercalators' Conference enthused undergraduates from across the UK (3.2). In Bristol ChemLabS, the Intensive Laboratory Element is being used as a catalyst for laboratory teaching elsewhere in the physical sciences in Bristol because of the educational benefits it is seen to provide, and the Dynamic Laboratory Manual is having an impact not only within the University but also in other UK higher education institutions (3.1) and potentially in schools (5.1.2).

1.2 Successful outreach programmes for both CETLs and interaction with external organisations

The outreach activities in each CETL have already brought very positive feedback, indicating their success in engaging with relevant external groups.

(Section 2 AIMS self-evaluation: 3.1–3.8, and Section 3 ChemLabs self-evaluation: 3.1–3.3, 4.1, 5.1.2.)

Outreach and public engagement activities for both CETLs include a range of work with schools, the HEA and professional bodies. The Mobile Teaching Unit has proved a great success for both CETLs and is a good example of the synergy arising from co-location of and co-operation between the Centres. The School Teacher Fellow post attached to Bristol ChemLabS is a great success, not only in respect of chemistry at Bristol but in providing a model for other subjects and institutions (Section 3 Bristol ChemLabS self-evaluation, 2.1).

1.3 Collaboration between the University and industrial partners

Both CETLs are involved in successful partnerships with industry. Examples are:

- ChemLabs has engineered commercial sponsorship of capital investment and outreach activities (3.3.3, 5.3)
- AIMS has been working with several partners: the BrainTower functional neuroanatomy model has received European Design Registration; the custom-designed operating tables in the CAS are being developed commercially by the manufacturers and AIMS staff are

working with the company that produced the HPS on further developments to improve the simulator's functionality, as well as with commercial software engineers to customise the specification of the Virtual Microscope.

2. Meeting aims and objectives

In our view, both CETLs are achieving their stated objectives successfully, mid-way through the external funding period. The unintended consequences mentioned are a combination of positive and negative factors, and we would have expected this to be the case. Section 2 AIMS self-evaluation (6) and Section 3 Bristol ChemLabS self-evaluation (6) summarise how each CETL is meeting its objectives. Further information can be found in the detailed sections for both AIMS and Bristol ChemLabS (main sections 2 and 3).

3. Challenges and opportunities

It is important to see the success of both the Bristol ChemLabS and AIMS CETL projects within the context of the University of Bristol as a research-led university. The need to balance commitments to both teaching and research presents the University a significant challenge, especially in an economic environment where other UK universities have withdrawn from teaching certain areas of experimental science because of the relatively high cost of creating and maintaining adequate and modern teaching facilities.

The CETL programme has offered the University a way of not only maintaining high quality teaching and learning, but of enhancing still further the quality of its provision. So far, it has allowed the University to establish a reputation for leading the way in innovative teaching methods in chemistry and medical sciences without devaluing the quality of its research activity, as well as raising awareness externally at different levels of creative and enjoyable learning opportunities.

We view the following as the main challenges and opportunities at this point in the CETLs' development:

3.1 Assuring sustainability

We recognise that securing funding beyond the life of the HEFCE support for the two CETLs represents a pressing challenge that will require a range of different strategies, including seeking industrial sponsorship, support from charities and public donations. We anticipate that a different approach may be required for the two CETLs, with Bristol ChemLabS being well positioned to seek support from industry, whereas for AIMS the emphasis may need to be on medical charities and individual donors. We are aware that long-term sustainability will additionally be enhanced by developing resource-efficient approaches to learning, teaching and assessment that also benefit student learning. Success in this respect will result in the most effective use being made of the resources (human and physical) in both CETLs and their associated subjects.

3.2 The effect of increased student numbers and reduced staff time spent on teaching

As can be seen from this report, the innovative and efficient learning and teaching methods developing in the CETLs have ameliorated some of the negative results arising from diminishing resources. However, as mentioned in section 5.1, we need to ensure that students do not associate innovation and changes to teaching and learning methods brought about through the CETLs, with economies necessitated by reduction in staff time or other resources that arise independently of CETL activities.

3.3 CETLs as a catalyst for departmental structures and management

This is one of the positive opportunities arising from the projects. Establishment of the CETLs has facilitated staff developments that were not necessarily anticipated. For example, CETL activity has:

- Provided opportunities for individuals to re-evaluate their career paths and for changes of direction
- Facilitated movement of staff between teaching specialisms, e.g. transferring teaching between programmes
- Led to cohesive and beneficial staff groupings, for example, those contributing to evaluating and conducting research into teaching methods used in the CETLs. Such teaching-based groupings provide many of the benefits of scientific research groups, and simply did not exist prior to the CETLs
- Raised the profile among departmental staff of the contribution to teaching being made by CETL staff (the less positive side of this point is that much of the additional workload arising from CETL activity falls on a comparatively small proportion of staff)
- Enabled individual staff, who contribute to the University predominantly through their teaching, to play to their strengths

It is clear that the different CETL structures in Bristol have had an effect on development of different activities. For example, the coherence and single discipline nature of Bristol ChemLabS has facilitated the successful establishment of partnerships with external sponsors; the multidisciplinary structure of AIMS has created staff opportunities — in particular it is encouraging staff across different departments to work together co-operatively and creatively. This is timely with the imminent merger of the Departments of Pharmacology and Physiology.

In summary we are very satisfied with progress to date but are not complacent. We will continue to seek opportunities for further development, integration and wider dissemination of CETL activities ,and for their sustained funding over the long term

Annex 1

Evaluation Framework for Bristol ChemLabS Centre for Excellence in Teaching and Learning (CETL)

1 Introduction

Evaluation of the activities of the Bristol ChemLabS Centre for Excellence in Teaching and Learning is essential for the following reasons:

- To assess and provide evidence to the CETL, School, Faculty and University of the progress and success of the CETL and the individual projects within it, and to learn from both intended and unexpected outcomes;
- To review CETL activities so that they can be adapted if necessary to respond to developments, or in the light of changing internal or external circumstances;
- To provide evidence to the Higher Education Funding Council for England (HEFCE) as well as other funding agencies that their investment has been worthwhile and is benefiting teaching and learning as envisaged in the subject(s) at the heart of the CETL and taking account of HEFCE's strategic learning and teaching priorities;
- To identify effective education practice that can be shared widely, both internally within the University and externally across the wider educational community.

HEFCE make it clear that for their purposes, 'monitoring' and 'evaluation' are quite distinct: monitoring is about progress in respect of business plans and finance, including spending according to schedule, and takes account of any serious problems in CETL business; evaluation is a critical (self-)assessment of the CETL's academic and related activities, as outlined above. There is also a clear distinction between evaluation and educational research. Evaluation involves consideration of the specific aims and objectives at the centre of the CETL's activities. Research may draw upon the results of both monitoring and evaluation, but is much wider. It may therefore include topics that, whilst related to the CETL's core activities, involve consideration of practice in other subject areas or of different teaching and learning methods. Thus whilst monitoring and evaluation are important responsibilities of the CETL team, educational research might also involve external partners.

The overall aim for evaluating the ChemLabS CETL should be to assure ourselves that we are achieving our objectives (academic and financial) and that projects are progressing with optimum success, improving student learning at all levels. The process of monitoring and evaluation will be overseen by a small working party that will report to the Management and Advisory Boards. The membership of the evaluation working party is given as an appendix. An External Evaluator will also be invited to provide an independent assessment of all areas of CETL activity at key stages in the project. The External Evaluator will, in general, be an academic chemistry specialist, able to comment in detail on subject-specific processes and achievements as well as broader educational matters. Detailed terms of reference for the External Evaluator are included as an appendix to this document.

The proposed framework below suggests different forms of evaluation appropriate to each strand of activity within the ChemLabS CETL. The External Evaluator may make use of the strategy and methods outlined in this document or may choose to initiate and use their own. The framework is informed by the most recent guidance from HEFCE on evaluation[14] and it is expected that this document will be revised as the CETL project progresses.

2 Possible evaluation methods and outcomes

It is suggested that evaluation needs to be based on both practical and theoretical approaches, with appropriate links between the two. To achieve this, some of the practical evaluation methods could link with educational research, for example, the effects of the CETL on student-learning outcomes.

Possible ways of evaluating Bristol ChemLabS' activities are proposed below. Broad evaluation themes will be based around the impact of CETL activities so far and will include:

[14] 'Evaluation of CETLs', letter and guidance note from HEFCE, dated 04 October 2006. See also http://www.hefce.ac.uk/learning/tinits/cetl/evaluation/

2.1 Student-learning opportunities and achievements, including a particular emphasis on the impact of the Dynamic Laboratory Manual as well as the effect of changes to the structure, timing and content of laboratory classes.

Proposed evaluation methods:

- Regular student focus groups, coordinated through external facilitators as well as members of ChemLabS staff;
- 'Spot' interviews with students in the laboratories;
- Whole-cohort end-of-module questionnaires;
- Consideration of the changes in responses given in the National Student Survey;
- Comparison of students' knowledge and understanding of chemistry and the development of their practical skills prior to and after the introduction of the ChemLabS programme through formal consultation with final-year research-project supervisors, employers and industrial placement supervisors;
- Comparison of student assessment results in practical work, using cohort analysis as well as longitudinal comparisons;
- Use of attendance, submission and other data to assess the changes in the motivation of students to engage in practical work and other activities as a result of the ChemLabS innovations;
- Consultation with representatives from bodies such as the Higher Education Academy and Royal Society of Chemistry who have an interest in the development of student-learning opportunities and achievements.

2.2 The impact of ChemLabS' teaching and learning approaches at Faculty and University levels, including the extent to which the two Bristol CETLs have been able to learn from one another's activities.

Proposed evaluation methods:

- Textual analysis of activities in both CETLs, using:
  - Comparisons of teaching, learning and assessment methods;
  - Student feedback and results;
  - Summary of plans for further development and initial thoughts about the impact of the CETLs' activities on other subjects / institutions;
- Interviews with staff involved in each CETL and with Faculty Education Directors in both CETL faculties and in other faculties.

This aspect of evaluation might well feed into the CETL Programme Evaluation planned by HEFCE.

2.3 Outreach activities, in Chemistry and more widely, and covering all types of outreach, including schools, University summer schools and other widening-participation events, as appropriate

Proposed evaluation methods:

- Questionnaires to staff in schools involved in outreach activities;
- Collating feedback from students involved in summer schools (questionnaires and other methods, e.g. reflective accounts, blogs, etc.);
- Interviews with the University Teacher Fellow and the School Teacher Fellow;
- Textual analysis of the impact of outreach so far, including joint activities with schools, the wider community and including continuing professional development related to outreach. This will include feedback from external visits (e.g. US Ambassador) and from overseas outreach events (e.g. China);
- Consultation with representatives from professional and industry bodies involved in outreach activities.

2.4 Continuing Professional Development and the way in which this has been promoted through Bristol ChemLabS at different levels, within the University and externally, to include research / teaching links.

Proposed evaluation methods in respect of University CPD:

- Internal interviews with staff associated both directly and indirectly with the CETLs, to assess the impact on their perception of the value placed on their CETL activities, internally and externally, to cover any potential impact on career progression, including promotion. The interviews would include asking individuals about the extent to which involvement with the CETL has affected the way in which research informs and leads teaching;

- Interviews with other University staff involved in rewarding and valuing academic staff and in particular their teaching activities, for example the Head of School, Dean, Pro-Vice-Chancellor (Education), covering some of the topics discussed with CETL staff;
- Focus group(s) with external individuals who have experienced CPD activities in chemistry led by the CETL.

The activities of the CETL project will also have an impact on the continuing professional development of teachers working in schools and colleges. It will be difficult to perform a comprehensive evaluation of this element of the project because it involves such a large number of external bodies. Nevertheless, useful information on both short- and long-term career development and changes in reward and recognition can still be obtained.

Proposed evaluation methods in respect of external teachers:

- Questionnaires and interviews with representatives of individual schools and colleges, local authorities, professional organisations and other external agencies such as the Science Learning Centre;
- Questionnaires and interviews with selected teachers.

3 Evaluation: structure of interim report and timetable

We need to ensure that the outcomes of our evaluation provide the Bristol ChemLabS CETL, as well as other individuals and groups in the University with an interest in its activities, with useful and reliable information. It is also essential that our results fulfil HEFCE's expectations of evaluation, as outlined in the guidance note mentioned above.

The interim evaluation report required by HEFCE has to be in two parts: A and B. The attached appendix (extract from HEFCE guidance note previously referred to) describes the content of each. As yet no template appears to be available on their CETL website.

HEFCE's deadline for receiving **interim evaluation reports is 31 July 2007**. They are also producing a CETL programme-wide report scheduled for December 2007, for public circulation in January 2008.

We therefore need to begin evaluating the data already collected as soon as possible for the Bristol ChemLabS interim evaluation report. The timing of the HEFCE deadline means that we may be able to take students' June 2007 results into account, if this is thought appropriate as part of the evaluation method.

Guidelines for External Evaluators of Bristol ChemLabS Centre for Excellence in Teaching and Learning (CETL)

This document sets out the duties and responsibilities for the External Evaluator of the Bristol ChemLabS Centre for Excellence in Teaching and Learning (CETL). The duties and responsibilities of the External Evaluator will be based on their role to act as an independent and impartial advisor on all aspects of the CETL Programme. They will provide informed comment both on the process and the academic standards set, as well as the level of student achievement in response to those standards. Their role will not be confined to consideration of assessment results alone; the External Evaluator will instead be encouraged to comment on the content, balance and structure of the CETL project as a whole.

The External Evaluator will be responsible not only for conducting independent and impartial evaluation but will also be expected to provide support to the Bristol ChemLabS CETL team in its own internal evaluations.

The External Evaluator will have responsibilities in each of the three areas of evaluation highlighted by the Higher Education Funding Council for England (HEFCE) and the Higher Education Academy (HEA):

- *Evaluation for Development*: to provide information and analysis for continuous improvement in order to ensure that the CETL is able to meet its stated aims;
- *Evaluation for Knowledge*: to monitor the educational outcomes and impact of the project, both within the School of Chemistry and the University of Bristol and the wider higher education community in order to inform future developments in the provision of teaching and learning;
- *Evaluation for Accountancy*: to ensure the collection of data for external monitoring purposes.

In addition, the External Evaluator will ensure that the University is able to compare the standard of practice and assessment within the CETL with those in similar environments in other higher education institutions. The University has its own internal quality assurance procedures, and attaches great importance to peer review from colleagues in other academic institutions, professional bodies, industry and commerce.

These Guidelines contain information on the following aspects of external evaluator services:

1. Appointment
2. Data protection
3. Role of the External Evaluator in assessing student work
4. Bristol ChemLabS Boards
5. Reporting
6. Discontinuation of appointment
7. Fees
8. Expenses
9. University procedure for the receipt of External Evaluator reports

1. Appointment

1.1 Only one External Evaluator should be appointed at any one time.

1.2 The External Evaluator will be nominated by The Bristol ChemLabS Management Team comprising the Chief Executive, the Director and the Manager. Formal approval will be sought from the Bristol ChemLabS Management and Advisory Boards.

1.3 Appointment will be for the duration of the Bristol ChemLabS CETL Programme to coincide with the five year period of HEFCE funding.

1.4 An External Evaluator will normally be an academic from another UK HEI, however there are cases where someone from a professional, statutory or regulatory body or from industry may be more appropriate.

1.5 Former members of staff and students should not be invited to become an External Evaluator before a lapse of at least three years or in the case of former members of staff, sufficient time for students taught by that member to have passed through the system, whichever is the longer.

1.6 The Teaching Support Unit will maintain a list of the CETL's External Evaluators.

1.7 When an External Evaluator is appointed, the Teaching Support Unit will send him/her:

- a letter of appointment, together with a fee/expenses claim form;
- a copy of the External Evaluators report form;
- the name of a contact person, nominated by the Bristol ChemLabS Chief Executive;
- a copy of these Guidelines;
- a copy of the University Assessment Guidelines;
- information about where to find University strategies, policies and procedures.

1.8 Bristol ChemLabS will send the External Evaluator as and when appropriate:

- details of those aspects of the CETL programme which involve student assessment;
- the relevant faculty and/or departmental assessment guidelines;
- details of any other aspects of the CETL programme for which advice is sought.

2. Data Protection

2.1 All personal data supplied by the External Evaluator for the purpose of their appointment and subsequently their employment as an External Evaluator will be held securely and for no longer than necessary.

2.2 The University will use this data for communication about and payment of fees and expenses and for any other necessary communications. This data may be shared, if necessary, with other departments of the University. The University will not disclose the External Evaluator's contact details or any other personal details to third parties (i.e. outside the University) without the consent of the External Evaluator.

2.3 External Evaluator's reports will be published on the national publicly accessible Teaching Quality Information (TQi) web site and on the Bristol ChemLabS web site. External Evaluators will not be identified by name, only home institution or professional status will be shown.

2.4 The External Evaluator should ensure that reports do not name or otherwise identify individual students on the programme or unit.

3. Role of the External Evaluator in assessing student work

3.1 The External Evaluator has the right to see all assessed work and any other work that contributes to laboratory unit marks.

3.2 The External Evaluator will be asked to comment and advise on all matters of the Bristol ChemLabS curriculum, balance and structure.

4. Bristol ChemLabS Boards

4.1 The External Evaluator will be a member of the Bristol ChemLabS Advisory Board which meets annually towards the end of the CETL year, typically in March or April.

4.2 Minutes should be taken of all meetings of the Advisory Board.

4.3 Bristol ChemLabS should ensure that as much notice as possible is given to external evaluators of the date of Advisory Board and other occasions on which they may be required to be present.

5. Reporting

5.1 A report should be completed annually in time for consideration at the annual Bristol ChemLabS Advisory Board meeting. The completed External Evaluator report must not name or otherwise identify students on the programme or unit.

5.2 The External Evaluator's reports should be addressed to the Bristol ChemLabS Chief Executive.

5.3 When the External Evaluator is submitting a report for the final year of his/her period of appointment it is an opportunity for the Evaluator to write an overview of his/her experience at Bristol ChemLabS. It should, therefore, include comments of a more general nature.

6. Discontinuation of appointment

6.1 Under certain circumstances, the appointment of an External Evaluator may be discontinued by Bristol ChemLabS or the individual Evaluator before the completion of his/her period of employment.

6.2 Where an External Evaluator resigns prior to the expiry of the appointed term Bristol ChemLabS is responsible for obtaining written confirmation of the resignation and finding a replacement.

6.3 In the event of unsatisfactory performance, Bristol ChemLabS reserves the right to terminate employment at any time during the period of employment. The decision to discontinue shall be based on a statement detailing the proposed grounds for discontinuation.

7. Fees

7.1 Bristol ChemLabS will determine the fee payable to each External Evaluator on the basis of a formula agreed by the University Planning and Resources Committee (UPARC) for External Examiners and reviewed every three years. This information is available on the University's Teaching Support Unit website.

7.2 The External Evaluator will be paid when Bristol ChemLabS has logged receipt of their report. The level of fee paid to an External Evaluator should be taken into account when considering whether to ask him/her to take on additional tasks.

7.3 The External Evaluator will be provided with a claim form to be completed and returned to Bristol ChemLabS, this claim form may also include expense details. For UK nationals the University is required to deduct income tax at the standard rate. Payments made to the External Evaluator are exempt from National Insurance deductions.

8. Expenses

8.1 Payment of the External Evaluator's expenses is the responsibility of Bristol ChemLabS.

8.2 The guidance of the Bristol ChemLabS Chief Executive should be sought on claiming for travelling expenses, especially where the costs of travel are likely to exceed the equivalent of second class rail fare or where travel by air is involved. The University's Regulations for Travelling and Subsistence Expense Claims is available from both the Finance Office and Teaching Support Unit websites.

8.3 The External Evaluator will be provided with a claim form. The details of the claim for travel, accommodation and meals should be completed and the form returned to Bristol ChemLabS. Reimbursement will be made only on the basis of actual expenditure incurred and therefore receipts must be included with the claim, all claims must be made on the appropriate form(s) and show the account number(s) to be debited.

9. University procedure for the receipt of the External Evaluator's reports

9.1 The reports received by Bristol ChemLabS will be considered in conjunction with a pro-forma within which the Chief Executive or nominee will note any issues, the actions required and any actions taken.

9.2 When an External Evaluator has made suggestions that require a response, Bristol ChemLabS should correspond with the External Evaluator to check that he/she is satisfied with that response.

9.3 The reports and all correspondence with External Evaluators will be logged by Bristol ChemLabS. External Evaluator reports and departmental responses should be appended to Annual Programme Review reports prepared by departments and sent to their FQAT Chair. The Teaching Support Unit will provide FQATs with a list of expected and received reports for each year.

Annex 2

Membership of Bristol ChemLabS Evaluation Working Party

Chair:	
Bristol ChemLabS Manager	Dr David M Smith
Members:	
Bristol ChemLabS Chief Executive	Professor Nick Norman
Bristol ChemLabS Director	Dr Paul Wyatt
Senior representative of Graduate School of Education	Dr Sibel Erduran
Director, University of Bristol Teaching Support Unit	Ms Gill Clarke

Membership of AIMS Evaluation Group

Chair:	
AIMS Co-directors	Dr Judy Harris Dr Richard Greene
Members:	
AIMS CETL Manager	Dr Jon Wakerley
External evaluator, University of Bristol Teaching and Learning Programme for Health Professionals	Dr Stephen Greenwood
External evaluator: Director, University of Bristol Teaching	Ms Gill Clarke

Annex 3

Relevant publications and presentations arising from CETL activities

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AIMS

Papers and articles

The Anatomy Demonstrator of the Future, A. Lockwood and A. Roberts, *Clinical Anatomy **20**, 455–459, 2007*

Using Human Patient Simulators in Physiology Teaching, J.R. Harris, *The Academy Subject Centre for Medicine, Dentistry and Veterinary Medicine Newsletter 01, no. 01/13*, 2007

'Stan-Power': Computer-controlled Patient Simulators as Novel Physiology Teaching Tools, J.R. Harris, *Physiology News: 61 p7-8*, 2005

Oral presentations at scientific and medical education conferences

The Integration of Human Patient Simulators with Physiology Teaching, J.R. Harris, To be presented as part of a plenary session on 'The basic sciences and medical education' at the *Annual Conference of the Association for Medical Education in Europe, Trondheim, August 2007*

Integration of physiology teaching with high fidelity Human Patient Simulators: one of the initiatives within the AIMS CETL, J.R. Harris. Presentation at the Breaking Boundaries meeting of the Academy Subject Centre for Medicine, Dentistry and Veterinary Medicine, Edinburgh, November 2005

Development of Human Patient Simulators for use in Physiology Teaching, J.R. Harris**.** *J Physiol: 567P, WA8 (at the joint meeting of the Physiological Society and Federation of European Physiological Societies, July 2005)*

Other oral presentations

Presentation by Dr Richard Greene on the **Clinical Anatomy Suite and the Mobile Teaching Unit** at a Scientific meeting of the Association of Surgeons of Great Britain and Ireland, Manchester, April 2007

Presentation by Dr Richard Greene on the **Clinical Anatomy Suite and the Mobile Teaching Unit** at the Royal College of Surgeons Conference, London, March 2007
Presentation by Dr Judy Harris on the **AIMS CETL** at the Inaugural Meeting of the South West CETL Cluster, Bath, February 2006

Poster presentations at scientific and medical education conferences

Using Human Patient Simulators to Address Current Challenges in Teaching Physiology, E. Lloyd, R.J. Helyer, J.R. Harris, (at the Annual Scientific Meeting of the Association for the Study of Medical Education, Keele, July 2007)

Integration of Human Patient Simulators with Existing Physiology Teaching for First Year Medical, Dental, Veterinary and Medical Science Undergraduates J.R. Harris, E. Lloyd, E. Richardson, M. Williams, R.J. Helyer, (*at the Annual Conference of the Association for Medical Education in Europe, Genoa, September 2006)*

Human Patient Simulation in Physiology Teaching: Designing a High Fidelity Cardiovascular Demonstration for First Year Undergraduates, E. Lloyd, R.J. Helyer, P. Dickens, J.R. Harris *(at the Main Meeting of the Physiological Society, London, July 2006)*

Using Brain Tower Models for Teaching Neuroanatomy, J.R.T. Greene (2007), poster presented to the 19th National Meeting of the British Neuroscience Association (Harrogate)

Demonstration at scientific meeting

Integration of High Fidelity Human Patient Simulators with Existing Physiology Practical Classes, J.R. Harris, E. Lloyd, A.T. Lovell, *J Physiol: 567P, D16 (demonstration at the joint meeting of the Physiological Society and Federation of European Physiological Societies, July 2005)*

University awards

Dr Phil Langton, Physiology, Faculty Teaching Prize, 2007
Dr Rich Helyer, Physiology, Faculty Rising Star Prize, 2007
Dr Alice Roberts, Anatomy, Faculty Prize for Public Engagement with Science, 2007

Dr Judy Harris, Physiology, Faculty Teaching Prize, 2006
Dr Liz Incles, Anatomy, Faculty Rising Star Prize, 2006
Mr Steve Gaze, Anatomy, Faculty Teaching Support Prize, 2006

Dr Eugene Lloyd, Physiology, Faculty Rising Star Prize, 2005

ChemLabS

Papers and articles

The Role of the School Teacher Fellow, D. E. Shallcross and T. G. Harrison, *Chemistry Education Research and Practice*, Volume 8 (1), January 2007.
http://www.rsc.org/images/STF%20letter%20final_tcm18-76285.pdf.

Reaching out to Primary Schools: The Bristol ChemLabS Experience, D. E. Shallcross, T. G. Harrison, S. Wallington and H. Nicholson, *Primary Science Review*, Issue 94, Sept/Oct 2006. http://www.ase.org.uk/htm/members_area/journals/psr/pdf/psr-94/reaching.pdf.

Perfume Chemistry, Sexual Attraction and Exploding Balloons: University Activities for School, T. G. Harrison and D. E. Shallcross, *Science In School*, Issue 3, Winter 2006. http://www.scienceinschool.org/repository/docs/issue3_perfume.pdf

Presentations

The Changing Nature of University Courses in Chemistry and Chemical Engineering
2nd February 2006, Presentation by Professor Nick Norman at a Chemical Education Group seminar, Salters' Institute, London

Outreach in Collaboration
18th October 2006, Presentation by Dr David Smith at a meeting organized by CELS, the Centre for Effective Learning in Science CETL at Nottingham Trent University

Bristol ChemLabS CETL
9th January 2007, Presentation by Dr David Smith as part of the 2007 Learning and Teaching Week at the University of Bristol

Sustaining Laboratory Facilities Chemistry in Higher Education
1st February 2007, Presentation by Dr David Smith, at a Chemical Education Group seminar, Salters' Institute, London focusing on the Royal Society of Chemistry's Chemistry for our Future Project

Bristol ChemLabS CETL
1st November 2006, Presentation by Dr David Smith as part of the departmental seminar series of the School of Biological and Chemical Sciences, Queen Mary, University of London

Bristol ChemLabS CETL
8th June 2007, Presentation by Dr David Smith at a meeting of science-based CETLs facilitated by the HEA Physical Sciences Subject Centre at the Open University

Parliament and Government

Higher Education Debate, House of Commons
15th March 2007, Discussion of the University of Bristol's outreach work in chemistry by Stephen Williams MP (Bristol West), Liberal Democrat Spokesman on Higher Education

Stephen Williams MP (Bristol West), Liberal Democrat Spokesman on Higher Education
16th December 2005 and 20th July 2007 Visits to Bristol ChemLabS

Giles Chichester MEP (South West of England and Gibraltar)
20th October 2006 Visit to Bristol ChemLabS

National Awards

Mr Tim Harrison, RSC Schools Education Award, 2005
Dr Dudley Shallcross, RSC Higher Education Teaching Award, 2005
Dr Dudley Shallcross, Higher Education Academy National Teaching Fellowship, 2005
Dr Dudley Shallcross, SCI Science Education Award, 2007

University awards

Dr Dudley Shallcross, Faculty Teaching Prize, 2006
Mr Tim Harrison and Dr Dudley Shallcross, Faculty Prize for Public Engagement with Science, 2007

Joint AIMS/ChemLabs activities

Joint publication:
Leading the field in teaching science and medicine. David Smith and Judy Harris, The House Magazine vol 31 p 23. Advertorial for the two Bristol CETLs

Joint AIMS/ChemLabS visit:
Mr Robert Tuttle, US Ambassador to the UK, 2 November 2006

Joint presentation:
The Bristol CETLs: a joint presentation by Nick Norman, David Smith, Judy Harris and student representatives from both CETLs at the annual meeting of University Court, December 2006