

Centre for Effective Learning in Science (CELS)

**A HEFCE-funded Centre for Excellence in Teaching
and Learning (CETL)**

Final Self Evaluation Report

School of Science and Technology

Nottingham Trent University

March 2010

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Director of CELS

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Part one – Statistical information

| | |
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| Name of CETL: | <i>Centre for Effective Learning in Science (CELS)</i> |
| Name of institution: | Nottingham Trent University |
| Contact name: | Dr Karen Moss |
| Name of person submitting evaluation: | Dr Karen Moss |
| Start date of CETL: | April 2005 |
| End date of CETL | Formally 31 st July 2010, however continuation planning is underway |
| Lead director & dates associated with CETL: | Dr Karen Moss (April 2005 to July 2010) |
| Total award: | <ul style="list-style-type: none"> • £2,000,000 capital • £500,000 recurrent pa • £350,000 extra capital |
| Use of capital: | <ul style="list-style-type: none"> • Capital: CELS Building – 3x seminar rooms (capacity 32 each), 1x lecture theatre (capacity 100), 1x school lab (capacity 32), 1x IT suite (capacity 31), 1x meeting room (capacity 8), 1x breakout room, 1x 4 person office, 1x 10 person office, 1x 1 person office, 1x IT project room (inc fixtures, fittings & IT equipment). • Extra capital: Optical observatory with 0.5m telescope, state of the art AV facilities, demonstration bench in lecture theatre, lab equipment, accessible vehicles, Virtual Reality kit, ballistics & projectiles kit. |
| Use of facilities in 2010-2011: | <ul style="list-style-type: none"> • The 3 seminar rooms, lecture theatre, IT suite & meeting room (designated as General Purpose Teaching (GPT)), will continue to be available for appropriate learning and teaching sessions. • Outreach activities & teacher CPD sessions will continue to be held in the building. • The building will continue to be used for every university recruitment session (Open Days) for the School of Science & Technology as well as the College of Arts Humanities and Education on the Clifton site. • The facilities will be used to host other open events e.g. public lectures. • The CELS laboratory will continue to be used for outreach & WP activities by the School of Science & Technology and NTU Schools, Colleges and Community Outreach Team (SCCO) • The Director’s Office and CELS Team Office space will continue for CELS activities beyond the cessation of HEFCE funding. The TIPS TOPS office (11 person space) will be used for staff in support of a range of academic activities. • The IT project room is used by academic staff who have research labs on same floor |

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|--|---|---|------|---------------|------|--|------|--|------|
| | <ul style="list-style-type: none"> The Trent Observatory and other teaching equipment will continue to be used for teaching undergraduates, carrying out projects embedded in BSc and MSc curricula and also enhancing outreach activities. | | | | | | | | |
| <p>Average no. CETL employees over 5 years (FTEs):</p> | <p>Average over 5 years is 9.43 FTEs on standard salary arrangements with a distribution as follows over the 5 year period.</p> <table border="0"> <tr> <td>Academic scale (CELS Director, 6.6 CELS lecturers)</td> <td style="text-align: right;">5.52</td> </tr> <tr> <td>Administrator</td> <td style="text-align: right;">0.85</td> </tr> <tr> <td>Other (Outreach Coordinator, Teacher Fellow, Outreach Assistant)</td> <td style="text-align: right;">2.19</td> </tr> <tr> <td>Other (e-learning development/website)</td> <td style="text-align: right;">0.87</td> </tr> </table> <p>[NB These posts were split between the Core CELS Team of Director, Administrator, E-learning developer, Outreach Coordinator, Teacher Fellow and latterly an Outreach Assistant and the 6.6 CELS lecturer posts.]</p> <p>In addition there was support for activities with staff who were bought out of regular teaching and assessment duties to carry out projects, support TIPSTOPS and evaluation for CELS (eg TIPSTOPS in other subject areas). This totals less than 0.2 FTE over 5 years.</p> | Academic scale (CELS Director, 6.6 CELS lecturers) | 5.52 | Administrator | 0.85 | Other (Outreach Coordinator, Teacher Fellow, Outreach Assistant) | 2.19 | Other (e-learning development/website) | 0.87 |
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| Other (e-learning development/website) | 0.87 | | | | | | | | |
| <p>What will staff do at the end of project?</p> | <p>Staff funded directly by the CETL are in 2 categories: core CELS team and CELS lecturers.</p> <p>Core CELS Team – Full time Director becomes part-time Director & part time academic. Depending on the success of the current business planning cycle up to 2 posts could be retained. 3 other posts will cease from end July 2010.</p> <p><i>Of the 6.6 FTE CELS lecturers, 3.6 have been appointed in 2009-10 to permanent posts (2.6 at NTU) others will be made redundant. [NB these were fixed term posts for 1 to 3 years to allow sabbatical release for seconded lecturers to TIPS-TOPS scheme. Of the 13 post holders over the course of 5 years, 6 CELS lecturers have achieved permanent lectureships in HE.]</i></p> | | | | | | | | |
| <p>Spin out projects funded:</p> | <p>There have been 14 financial projects where funds have gone in one of two ways: either spin-out or spin-in.</p> <p>6 funded areas were not in the CELS bid plus there were additional funds gained to do activities not in original proposal</p> <p>Spin out (£42K)</p> <ol style="list-style-type: none"> <i>TIPSTOPS style projects in other subject areas</i>, £36K. Funding for six £6K TIPSTOPS projects in subjects areas at NTU not part of original bid - Computing and Informatics (C&I) Animal Rural and Environmental Studies (ARES). <i>Nottingham Science City (NSC)</i>, £1.5K (see www.science-city.co.uk) as leader of NSC Education & Training Group – staff time, catering and room space. <i>Korean Summer Camps</i> in 2008 & 2009, £5K. Joint events with staff time from CELS for two weeks all other costs by Korean partners. <i>Data Logger project</i>, £3K with School of Education (NTU) & Loughborough University. <i>Dragon Breath Theatre Productions</i> (School of Art & Design NTU) £5.5K Funding for teaching resources/workshops as part of ICARUS & COSMOS | | | | | | | | |

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| | <p>6. <i>Astronomy outreach</i> and public engagement work- transport and catering.</p> <p>Spin-in - Incoming funding in addition to HEFCE grant (£236K)</p> <p>7. Development of <i>Kit in a Kase</i>, £93K, partially supported through funding obtained from regional development agency (emda) for 4 Kit in a Kase activities for local Science City themed topics</p> <p>8. <i>Ogden Trust Kit training scheme</i>, £3K, training students to deliver activities</p> <p>9. <i>ICARUS & COSMOS</i>- through seed funding by CELS (£5.5K)& others won Arts Council England Funding (£53K for COSMOS)</p> <p>10. <i>Curriculum Development</i> for HE Chemistry programmes (Chemistry for our Future, £85K over 3 years)</p> <p>11. <i>Joint NTU SPUR student bursary</i> £1K (NTU RIT funding) with Prof Ireson (Education) on superconductivity</p> <p>12. Work as member of <i>EUSCEA</i> (European Science Events Association) which led to €16K of FP7 Science in Society funding for 2WAYS project on Genetics outreach (with CALMAST – University of Waterford and University of Leicester)</p> <p>13. <i>LG-NTU English Science Summer Camp</i> (£9.6k) as part of a £120K project with LG in South Korea</p> <p>14. <i>Co-funding for Outreach activity</i> with other STEM organisations (not in bid) brought in £62K</p> |
| <p>No. peer reviewed outputs:</p> | <p>23 Peer reviewed outputs (details in Annex A)</p> <p>NB includes all conference papers /posters that were selected through 'peer review' processes and published in Proceedings with ISBN numbers.</p> |
| <p>Up to 5 other outputs not peer reviewed:</p> | <ol style="list-style-type: none"> 1. <i>Careers materials</i> for schools for chemistry , biology and physics careers – poster & leaflets 2. <i>Self teach CDROM</i> (produced for HEA Physical Sciences Subject Centre workshop on Flash animations, Excel and PowerPoint) 3. Gina Manning & Karen Moss, <i>Going Public – Getting the bug in schools</i>, Published in Microbiology Today, May 2009 4. Stephen Forsythe, <i>Teaching the 'BIO' in Microbial Bioinformatics</i>, Published in Centre for Bioscience Bulletin, Summer 2009 5. Gina Manning & Karen Moss, <i>Practical Skills in Biology – Engaging Your Future market</i>, Published in Centre for Bioscience Bulletin, Spring 2009 |
| <p>No. events held to develop/disseminate work beyond CETL in last 3 years*:</p> | <p>In terms of papers/posters/ workshops and talks, since January 2007 CELS has delivered over 62 dissemination activities - of which 43 were to external audiences and 19 were to internal audiences. In terms of outreach activities over 650 sessions have been held since November 2005 attracting over 26,500 young people (List on web site www.ntu.ac.uk/cels/about/work/dissemination_activities/index.html, and fuller details are also given in Annex H)</p> <p>External events include:</p> <ul style="list-style-type: none"> • Papers at International Scientific /Pedagogic Conferences, • Presentations to a Minister of State and Kenneth Clark, MP, • Talks to UK companies, • International science festivals, • Presentations at Aim Higher conferences and Careers events and • Wide range of sessions about outreach <p>[NB This list does not include specific outreach activities themselves].</p> |

Part two – Evaluative reflection

Question 1

The following section reflects on how effective CELS has been in contributing to the objectives set out for the CELS initiative namely:

- 1) *To reward practice that demonstrates excellent learning outcomes for students.*
- 2) *To enable practitioners to lead and embed change by implementing approaches that address the diversity of learners' needs, the requirements of different learning contexts, the possibilities for innovation and the expectations of employers and others concerned with the quality of student learning.*
- 3) *To enable institutions to support and develop practice that encourages deeper understanding across the sector of ways of addressing students' learning effectively*
- 4) *To recognise and give greater prominence to clusters of excellence that are capable of influencing practice and raising the profile of teaching excellence within and beyond their institutions.*
- 5) *To demonstrate collaboration and sharing of good practice and so enhance the standard of teaching and effective learning throughout the sector.*
- 6) *To raise student awareness of effectiveness in teaching and learning in order to inform student choice and maximise student performance.*

1.1 TIPS-TOPS (objectives 1,2,3,4&5)

We met these objectives through our innovative secondment scheme known as TIPS-TOPS (Teams for Integrated Projects in Science, Teams for Outreach Projects in Science) which:

- a) Enhances the student learning experience.
- b) Provides career development posts for aspiring academics;
- c) Offers time and space to develop learning and teaching in science;
- d) Develops staff scholarship of learning and teaching;
- e) Encourages collaborative learning and dissemination;
- f) Delivers resources to enhance the teaching of science and technology;
- g) Develops staff profiles for promotion;

TIPS-TOPS delivery is scaffolded by a development programme which includes: getting publishing (pedagogical journals), evaluation methodology, action learning sets, reflective practice, portfolios and structured dissemination events. This enables staff to share ideas and experiences across subject boundaries enhancing their projects. TIPS-TOPS project holders developed: new teaching resources, e-learning modules, flexible learning modules, new assessment approaches, new methods of teaching programming, forensic science- and chemical-practical courses, addressed diverse learning needs and produced outreach activities. These have had a significant impact on teaching practice of TIPS-TOPS staff

'Personally, I can see myself getting 'addicted' and wanting to get more and more involved as time goes on.' 'The project gave me an opportunity to identify the gaps in students' knowledge and skills.'

and the student learning experience...

'An important part of the embedding process has been with myself and the way in which I now teach.' (see sections 4.2 & 8.2).

Projects were chosen to deliver both CELS objectives and meet strategic learning and teaching needs within science and NTU. Outputs have been disseminated at university, national and international conferences, articles written for national publications and scholarly journals and there is growing commercial interest in certain aspects of our work. (Annex A: List of publications/outputs, Annex B: List of TIPS-TOPS projects). One person used their TIPS-TOPS project within their successful application for a chair. Two other CELS staff achieved a PG Diploma in Research Informed Teaching.

1.2 CELS lecturers (objectives 2&3).

The appointment of CELS lecturers was an innovative model to enable project delivery through TIPS-TOPS. These three year fixed-term lectureships are within academic subject teams in the School of Science and Technology at Nottingham Trent University. These 'career development opportunities' were aimed at 'early stages' applicants with potential but limited experience and offered the full 'lecturer' experience (including training via completing the PgCertHE (HEA validated programme)). CELS lecturers allow academic teams to release staff to undertake sabbaticals on teaching and learning projects. Their validity as career development opportunities has been clearly demonstrated: 6 of the 13 post holders have achieved permanent academic appointments, 5 of these at NTU. The CELS lecturers feel they have made substantial contributions to the development of teaching and outreach activities and developing their research profiles. (Section 11.6)

1.3 Capital (objectives 1& 2).

Learning space and equipment that impact on quality of learning are another aspect of reward. We have significantly improved the teaching facilities at the NTU Clifton Campus through our high quality general purpose teaching rooms, (details, Part 1). Our flexible space allows a wider range of teaching interactions as well as other activities (c.f. traditional fixed-seat lecture theatres) e.g. group work, peer assessment, oral presentations, hosting masters exhibitions (Bioscience & Heritage Studies), student competitions, academic development workshops/conferences, plus extending the type of outreach activities offered eg Activity Days. The CELS Lab has significantly benefited younger children by delivering facilities to carry out practical activities on site and supports teacher training. The TIPS-TOPS office allows staff opportunities to get out of their normal office, to have space and time to reflect on their teaching, and develop their ideas.

1.4 Additional capital (objective2)

This capital provided the optical observatory with its 0.5m telescope, state of the art AV facilities, lab equipment, accessible vehicles, Virtual Reality Kit, and Ballistics & Projectiles Kit. Examples of impact include the extensive Astronomy based outreach programme (Section 10.6); and use of Ballistics resources in new experiments for Forensic Science, student project work and the successful TOPS project Physics for Forensics, an inquiry-based competition involving 36 schools, 37 teachers & 144 pupils, which has run six times

1.5 Outreach (objectives 4,5 &6)

Our student 'audience' includes schools (pupils & teachers) through cutting edge outreach (sections 2&4). One particular innovation is the Kit in a Kase (KiaK) model to support more effective science learning. Kits cover a wide range of topics and age-groups, (Annex C), and are highly rated by pupils and teachers (section 3.1).

1.6 Collaboration (objective 5)

A particular feature of CELS outreach work has been its collaborative nature:

- Sharing best practice through national events held jointly at CELS with HEA UK Physical Sciences Centre in 2006 and 2008; (*Outreach in Collaboration* workshop and *Outreach in Collaboration II* conference) each event attracted over 50 HE participants from UK & Ireland.
- Delivering activities in partnership with: Professional bodies (RSC, IoP, IoB); The Regional Development Agency (Go4SET- engineering, Lab13 at Dovecote School, *Come Alive with Science*), Chemistry: The Next Generation (biannual joint events with Loughborough, Leicester, Nottingham, NTU & Astra Zeneca).
- Putting learning resources for schools on website (Annex D).

1.7 Student awareness (objective6)

Student engagement with 'effective learning' is through:

- TIPS projects on teaching and learning
- School placements (*Communicating Science & Technology Module*- derived from Undergraduate Ambassadors Scheme(UAS)) to explore teaching and develop employability skills
- Conducting projects in science education
- Voluntary work in outreach

1.8 HEFCE's CETL aspirations

We also measure the effectiveness of CELS against HEFCE's original aspirations for CETLs (call sections):

'CETLs will recognise, celebrate and promote excellence by rewarding teachers ... sustain and stimulate further excellent practice through teaching that is informed by scholarly reflection, developed through innovative and adventurous thinking,

extended through tested knowledge to learning in new contexts, and multiplied by active engagement in dissemination of good practice, (16)

'will have taken risks, pioneered innovative learning approaches and significantly extended the use of new technology, (20)

'the relationship .. with the HE Academy and its Subject Centres, (22)

'areas for CETLS (29)

- *A form of teaching (distance learning, online learning, mentoring)*
- *A way of conceptualising, organising or supporting student learning (lab practice, skills support, special needs, peer tutoring)*
- *A way of designing the curriculum (problem-based learning, work placements, cross-disciplinary thinking, internationalising the curriculum)*
- *A way of designing student assessment to enhance and deepen learning (work and placement-based assessment, formative assessment, self- and peer assessment; alternative forms of assessment for students with special needs, understanding and avoiding plagiarism)*
- *A way of involving students in active understanding and monitoring of learning effectiveness (use of feedback, learning logs and portfolios).*
- *A goal of higher education (enhancing social inclusion, widening participation, enhancing employability, promoting enterprise and creativity, autonomous learning)*

NB of the 44 exemplars of indicative areas of activity, CELS' outputs cover 26. Hence CELS can show a significant achievement in meeting the original vision for CETLS. We did this through:

- 1) Our innovative TIPS-TOPS scheme;
- 2) A cutting edge programme of outreach activities and projects coordinated by the core CELS Team;
- 3) Innovation in the student learning experiences;
- 4) Delivery of a high quality learning environment.

[1175 words of which 200 are CETL bid quotes]

Question 2

Please set out the aims and objectives specific to your CETL at the start; and for each one reflect how well these have been achieved. Be concise and do not exceed 1,000 words for the whole of the question.

2.1 CELS Aims

We addressed all our aims, excelling in three areas in particular.

2.1.1: Spreading excellence in teaching recognised at the highest level by HEFCE/QAA reviews of established core science provision to the developing and increasingly popular interdisciplinary sciences.

TIPS-TOPS projects combined core science areas of chemistry, physics and biosciences and the newer sciences of forensic science, sport, computing & technology and animal studies (Annexes B, E), the outputs have had a very positive impact both within NTU and externally.

2.1.2: *Allying scientific learning to outreach activities in science – with a particular emphasis on schools within areas of current low aspiration and progression to university.*

Our radically different vision of science outreach, developed an extensive programme that focuses on quality of learning, tackles difficult scientific concepts and promotes scientists as people - across disciplines and to socially diverse groups (section 4.3)

2.1.3: *Development of novel methods for measuring the effectiveness of different approaches of learning.*

This one area proved challenging on ethical and methodological grounds, a new approach has evolved (section 2.2.5).

2.1.4: *Student participation in a range of outreach activities and collaborative work with the NTU's Progression Partnerships Team and the Royal Statistical Society Centre for Statistical Education (RSSCSE).*

We exceeded this aim in innovative ways, engaging science students with final year educational projects (17 students); Communicating Science and Technology module (65 students); the Ogden Trust scheme and Volunteering; (63 Kit volunteers since 2006; in 2009-10, 12 students supported on-site activities, 35 student volunteers (UG & PG) registered).

Our successful collaboration with the RSSCSE on ExperimentsAtSchool (www.experimentsatschool.com) developed interactive Adobe®Flash®-based experiments, which capture the abilities of participants to estimate quantities or respond to particular stimuli (section 8.3). These resources are promoted to UK schools and internationally.

NTU's Widening Participation team (Progression Partnerships), helped develop training for UAS students. We promote recruitment to their *Student in Classrooms Initiative*, and CELS supports science activities within NTU's *Summer Schools; Activity Workshops* and *Primary Experience Days*.

2.2 Five CELS Objectives

2.2.1: *Applying existing models of learning (Concept Learning(CL), Context-Based Learning(CBL), Problem-Based Learning(PBL)) to develop new materials in a range of delivery formats.*

This objective is delivered through TIPS-TOPS activity:

- We identified concepts level four science students find difficult, using surveys, focus groups and diagnostic tests. Cutting edge pedagogic theory was employed (*Threshold*

Concepts and Troublesome Knowledge) and results reported e.g. *2nd Science Learning and Teaching Conference* (Annex A, H, section 7.2).

- Resources to support conceptual learning include flash animations for moles and dilution factors (CELS website www.ntu.ac.uk/cels); TIPS projects in *Computer Programming*; *Bioinformatics*; *Green Chemistry*; *Stats for scientists*; plus KS2 Primary Resource '*Forces & Flames*'.
- Our Neural Network system was trialed (2005-7) in two studies but was not effective (section 5.3). Further *E-learning* resources were created for a range of students, e.g. *Protein Purification*, *Bioinformatics*.
- Context-based materials for lectures and labs were developed: *Criminalistics* and *Environmental Science*.
- Many outreach activities are context-based or inquiry-based: *Chemical Whodunit*; *The Dysentery Outbreak*; *Physics of Forensics*.

2.2.2: *Developing supporting learning material for entrants to HE with non-standard backgrounds.*

There were 4 key and effective projects in this area.

- The Molecular Geometry resource (www.ntu.ac.uk/cels/molecular_geometry/index.html) was developed in response to knowledge gaps identified by Forensic Science students. Positive feedback and web stats show it has been extensively used both nationally and internationally across 5 continents – Europe, Americas, Oceania, Asia and Africa.
- Practical work is a key employability skill for scientists addressed by several TIPS projects: *Forensic Skills Development in Criminalistics Practical Work*, *Learning Materials to Support the Acquisition of Key Practical Skills in Bioscience*; *Use of multi-media to Support Student Learning in Standard Operating Procedures for Laboratory Work*.
- A bridging programme is being developed to support FdSc students transferring to year 2 of BSc programmes.
- E-learning modules (Flexible Masters in Bioscience) have been developed and used by UK and international students e.g. *Research Methods & IT*, *Molecular Biology*; *Cell Culture and Antibody Technology*

2.2.3: *Applying the results of the FDTL phase 4 project 'Effective Feedback, Enhanced Learning' (EFEL). In addition, use materials from the Achieving Accessible Assessment Project at NTU.*

The sports team who have embedded outputs from EFEL required more efficient methods to assess large student cohorts and build feedback practice to ensure feedforward. They developed applications for optical reader technology, assessment grids, feedback that

feeds-forward, embedding self- and peer-assessment approaches and a project critically evaluating automated systems for essay marking.

Other projects continued the assessment theme, not on feedback but on areas of identified need such as designing out plagiarism, accessibility, reduction of assessment load and harnessing technology e.g. projects in "*Issues on the assessment & evaluation of distance E-learning modules*"(TIPS, 2008-9); "*Preparing school students to avoid plagiarism*" (TOPS,2009-10, promoting good writing habits with 'A'-level students); "*Creating an accessible learning and teaching environment in the School of Science and Technology*"(TIPS, 2008-9, accessibility guidelines for teaching, learning and assessment applicable to whole of university);

Extensive experimentation with formative assessment, using voting technologies (PRS) has been undertaken at CELS outreach events and presented to international events, e.g. Interactive Technologies Conference in 2009 (paper submitted to journal *Computers & Education*).

Qualitative non traditional approaches to assessment were introduced for *Communicating Science and Technology Module* (reflective weekly log book, literature review, skills assessment by teacher, written project report and oral presentation), and the Biosciences radical competency-based *Portfolio for practical work* which reduces assessment load. Both of these experiences enhance employability.

2.2.4: *Raising aspirations of local people through outreach work. A credit-rated school placement for science undergraduates will be developed.*

We exceeded this objective with innovative approaches to outreach involving over 26,500 school children aged 5-19 (e.g. Kit in a Kase, see sections 3.1&4.3). This scale of activity was achieved using a combined resource model: CELS Team, TOPS projects, and student projects on resources/activities for schools. We have improved pedagogic design in outreach to promote 'minds-on science' using Inquiry-Based Learning approaches.

Communicating Science and Technology (school placement) module is a big success. From 8 chemistry/forensic science students in 2005/6, this year the module was oversubscribed with 22 students applying from chemistry, forensic science, physics, bioscience, computing & technology programmes. Of 43 students who completed this module, 7 are in/have completed teacher training. [NB excludes current cohort.]

2.2.5: *Developing innovative methods for measuring effectiveness of different learning approaches.*

This objective was identified in the original bid as the one with the highest risk. In practice it presented significant challenges in designing suitable, ethical educational experiments for effective comparisons of learning approaches. Ethically, we were advised that getting approval for a study would be difficult in an academic climate that prizes equity and transparency. Students are substantially risk adverse regarding changes that

may affect their course assessment, even when those changes have the potential to simplify learning. Debates centred on the balance between quantitative and qualitative assessment of effectiveness of learning. Our research showed that qualitative assessments of effectiveness can measure delivery of learning objectives, e.g. through portfolios and more recently concept mapping. We began two projects in these areas (2009-10). Here we switched to evaluating effective learning within TIPS-TOPS/CELS projects using approaches such as personal response systems (PRS) to evaluate outreach events and measure their effect on conceptual understanding of pupils /adults [e.g. the Test-Teach-Test model].

[1193 words- 175 are quotes of aims & objectives]

Question 3

Please add any objectives that emerged as the CETL developed, and reflect on these as for question 2. (500 words maximum)

Four objectives emerged during our lifespan.

3.1 *Kit in a Kase*

We remodelled 'Outreach' into activities where we could measure impacts on learning. From 2006 we dropped some larger events (500 footfalls per day) to focus on smaller groups (~30 pupils) where we could more thoroughly evaluate each session. A major vehicle became *Kit in a Kase*. Kits use a guided enquiry 'hands-on' pedagogical model, delivered in schools, stimulating interest in science curriculum¹. Our 12 kits (Annex C) cover topics from year 1 (*Animal Detectives*) to year 9 (*Light-Up Materials*).

In 2006, 26 sessions were delivered to 650+ students. Now we deliver 70 Kits annually in over 45 schools, around 11,500 children have experienced Kits. Teachers' evaluations state '*Excellent balance of input drew out knowledge and experience*'; '*Links with real life are extremely valuable*'; '*Explanation & visual representation of a complex concept - Allowed kids to see role model*'; '*Highly relevant to syllabus.*'

Students volunteer to help deliver Kits. To support increasing demand, we developed a scheme funded by the Ogden Trust, whereby students are trained and paid to deliver Kits for themselves. Our innovation was recognised by the Regional Development Agency, with funding of £93K to develop four Kits on local science for Nottingham Science City.

3.2 *Regional STEM promotion*

CELS became a focus for regional promotion of STEM, via working groups of Nottingham Science City (<http://www.science-city.co.uk/>): CELS Director chairs the *Education & Training Group*, (with 20 regional organisations promoting STEM education, engagement & careers); the *Future Skills Group* focuses on strategic workforce development planning

¹ [Model developed from 'Oil Slick' shared with us by Dr Tang (University of Nottingham)]

(with sector skills councils), informing regional skills strategies. CELS participates in the Advisory Group of the East Midlands STEM Partnership and its forum events for employers, educational organisations, careers advisors and local authorities across the region. These have given CELS regional recognition as a model of good practice and as an important driver for the involvement of universities in partnerships promoting the wider regional STEM agenda.

3.3 *Crossing boundaries*

3.3.1 *Interdisciplinary frontiers*

Collaborative projects in Science and Art have developed cross-disciplinary relationships and achieved critical acclaim. CELS supported (training, expertise and small grants) two theatre productions with Dragon Breath Theatre Company (based at NTU): ICARUS and COSMOS. ICARUS (Ethics of Stem Cell Technologies for GCSE students) was nominated for Times Higher *‘Excellence and Innovation in Teaching the Arts’* Award, papers on ICARUS were presented at IX-World Congress on Bioethics and International Science in Society Conference. For COSMOS (astronomy for 4-6 year olds), our grant supported a successful application for £53K to Arts Council England by Dragon Breath for production/teaching resources. COSMOS ran to capacity in Nottingham and Leicester at *Spark Children’s Festival*, (now shortlisted for national *Brian Way Award for Young People’s Writing*).

“I came away from Icarus really moved, confronted with the personal side of a scientist’s work and research, and challenged about the ethics of what I’ve been studying day in, day out” Medical Student, Kings College London

COSMOS research findings include: (*Research in Drama Education* paper)

‘Children achieved either ‘secure’ or ‘partial’ understanding of all the scientific concepts in ‘Cosmos’.

‘Performance which employs complex multiple forms can have an impact on scientific understanding because of its multi-sensory and multi-textual fabrication.’



Participating in COSMOS

3.3.2 *Crossing Borders*

International dissemination has involved conference presentations, European projects, delivering outreach sessions, good practice workshops and FP7 bids. We have partnerships with South Korean organisations to develop our science education resources for their markets. We ran two sponsored summer science camps in Korea, the LG Corporation sponsored the 2009 camp.

[580 words]

Question 4

Irrespective of your answers to questions 2 and 3 above, please reflect on, and draw out the achievements and benefits of the CETL (1000 words maximum). (Think about different audiences, types of output, impact internal and externally, on professional/staff development, on student learning, work over an extended period, use of money for facilities development etc.)

4.1 Benefits

There have been immediate benefits for NTU that are quantifiable over the lifespan of CELS e.g. individual staff through professional development; the quality of the student learning experience; introducing innovative models of outreach; scale of outreach now delivered regionally; enhancing the learning environment through provision of physical spaces/equipment we provided and new interdisciplinary projects. There are external benefits too through new partnerships- across disciplines; across institutions and across international borders- with good practice shared at regional, national and international events and conferences. In some areas (work with young people), benefits are yet to materialise as the focus is on building future capacity for HE. Work with NTU's Schools and Colleges team (SCCO) will seek to harvest the seeds sown in the longer term. Finally there are qualitative 'soft' benefits for participants in terms of developing intrapreneurial competencies such as risk taking and creativity.

4.2 HE staff and students

Overall TIPS-TOPS has impacted on the learning experience of over 4000 HE students (from 22 staff who did projects up to summer 2009), resulting in case studies and 23 peer reviewed conference papers and journal articles. [Annexes A & B]. Staff also said *"It was thoroughly useful and worthwhile"*; *"Many of the long term benefits come from reflection but time is needed for this."*

4.3 Scale of Outreach

One of our main achievements has been the scale and range of outreach that CELS has undertaken, benefiting over 26,500 young people in the region (plus young people at European science festivals, Korean science camps, and regional public engagement events for 14,000+ people.) In this region (see figure 1), CELS has promoted science and technology to all ages and all social groups bringing wider recognition of HE and NTU.

Table 1 Breakdown of pupil & school interactions 2005-2009

| Calendar years | 2005 | 2006 | 2007 | 2008 | 2009 |
|-------------------|------|------|------|------|------|
| No. pupils/ year | 569 | 4567 | 5981 | 7035 | 7382 |
| Primary | 300 | 3212 | 4173 | 4283 | 3824 |
| Secondary | 113 | 643 | 1330 | 2390 | 2874 |
| Post 16 | 156 | 712 | 478 | 362 | 684 |
| Total No. Schools | 24 | 162 | 174 | 180 | 220 |

Figure 1 Map showing locations of schools CELS has worked with



Before CELS, activities were run by a small number of academic science staff and by NTU WP team Progression Partnerships [footfalls were around 2000 pa (1200 came from a single 3-day primary event with SCITEC.) Through CELS, a dedicated outreach coordinator and a teacher fellow were appointed (and led by rising demand, to an outreach assistant), this allowed better coordination both at NTU and with regional activities.

The CELS investment developed new materials and types of activities and provided sabbaticals to develop new approaches/resources (TOPS projects in *Physics for Forensics Competition*; *Outreach Coordination in Biosciences*, *Green Chemistry Practicals*; *Who Killed Clarissa the Chicken?*; *Ronnie the Skateboarder*, *Avoiding Plagiarism in Schools*). More staff now regularly engage with outreach-type activities-7 before CELS, now over 20)

Outreach arising from the investment in CELS now includes (summary in Table 2): Masterclasses (KS4 & 5); Kit in a Kase (in 5 counties including the inner city); careers events with AimHigher & Connexions(*What Next?*); regional collaborations with *Chemistry: The Next Generation*; *GENIE* CETL and East Midlands STEM Partnership; competitions; bespoke events for Education Improvement Partnerships; WP summer schools; taking work experience students; astronomy programme; Lab13 activities (first in UK, on local council estate); *Activity Days* on site; UAS module; lectures and career talks on site and in schools.

Our audiences are now much richer and broader both in the number, type and location of schools reached plus sessions carried out with community groups (brownies, guides, rainbows, scouts, cubs, beavers) home learners, young mums, and children in hospital. We have developed parents and child events e.g. *Nappy Power*. Our work is supported by the regional development agency and professional bodies. In later stages we have begun to focus more directly on teachers themselves – through our growing profile of teacher CPD.

We also focused on learning gain: we developed new evaluation schemes based on best practice (by BSA) and integrated the use of voting systems (PRS) to gauge impact of an activity on science learning.



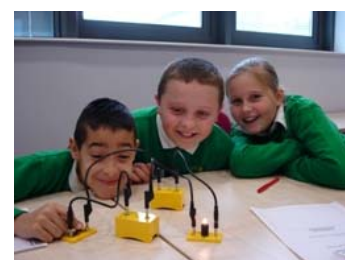
**Ronnie the Skateboarder
KS4 physics in local school**



Physics for Forensics @NTU



**'What's my Job?'
at C:TNG event @ NTU**



**Physics Fun in February
Activity Day @ NTU**



**Brownies meet Microbes
Science badge activity @NTU**

Table 2: Impact of CELS on Science Outreach Activities

| Before | After |
|---|--|
| 1. <i>Amazing Magical Science</i> show (external speaker) | 1. Activity Days- primary science |
| 2. Chemistry lectures for schools | 2. Activity days – secondary- forensic, materials |
| 3. Chemistry master classes | 3. Amazing magical science show |
| 4. Physics for Schools | 4. <i>Animal Extravaganza</i> |
| 5. Primary microbiology | 5. Archaeo-astronomy summer school |
| 6. Science student projects | 6. Astronomy events |
| 7. Science activities for NTU Summer Schools | 7. Bespoke workshops |
| 8. Sci-tec primary event | 8. Biology 6 th Form conference |
| | 9. Careers event |
| | 10. Chemistry: The Next Generation regional events |
| | 11. Competitions- <i>Physics of Forensics, RSC Young Analyst, Salters Chemistry Festival, IOB Poster Competition</i> |
| | 12. Joint events with other centres CALMAST /GENIE |
| | 13. Dragsters Bronze CREST award |
| | 14. Dragon Breath theatre productions <i>Icarus & Cosmos</i> |
| | 15. European festival events |
| | 16. <i>Float Your Boat</i> activity day |
| | 17. Forensics CPD for teachers |
| | 18. Gene therapy seminar |
| | 19. Go4SET engineering team project |
| | 20. Headstart – CREST Bronze |
| | 21. Kit in a Kase |
| | 22. Korean science camp |
| | 23. <i>Lab in a Lorry</i> |
| | 24. Lectures – <i>Forensic Science /Nanotechnology /Fuels/Choc/Fireworks/Chemical demonstrations /MRI/ Vampire Bacteria/Medicine/ Fine Art/Flesh eating Bacteria/</i> |
| | 25. <i>Maggots, Murder & Mystery</i> |
| | 26. Master Classes– <i>astronomy, Computing, DNA, Forensic Microbiology, Microbiology, Paracetamol, Rates of Reaction, Speed of Light, Pig Flu, Green Chemistry, Sport, Synthesis & Spectroscopy, Bird Flu</i> |
| | 27. Public engagement Nano-Roadshow, Nottingham |
| | 28. Primary workshops- <i>Minibeasts, Nappy Power, Forces & Flames, Slime, Animals and Plants</i> |
| | 29. Scouts/Brownies sessions – science, stargazer |
| | 30. Skateboarding Ronnie – physics workshop |
| | 31. Work experience students |
| | 32. WP/AimHigher summer schools & university days |
| | 33. Young Engineers for Britain/K'NEX challenge |

(A full summary of activities is in Annex F)

4.4 *Spin outs*

Through a range of spinout funding and partnerships we have added value to audiences beyond the original vision, e.g.

1. Collaborations with Art & Design produced theatre productions (section 3.3), science-art exhibitions; sci-art sessions at summer camps in Korea;
2. Professor of Science Education, (appointed NTU 2007) has facilitated work by CELS with trainee teachers (how to do chemical demonstrations safely, inquiry based maths, Kit in a Kase) and partnered CELS in European and Korean activities. A joint project with CELS, NTU Education & Loughborough University used CELS funding for a prototype data-logger kit which students self-build. They were used with 20 trainee science teachers and a class of 30 year nine pupils in a local school. The final part of the evaluation is being carried out through Loughborough University with trainee Science & Technology teachers;
3. Applying CELS capital funding to related cognate areas² of Computing & Technology (C&T), (VR equipment for use in multimedia programmes) and Animal, Rural and Environmental Studies (ARES), (accessible vehicles for their campus);
4. Funded two part-time sabbatical projects a year to members of C&T and/or ARES staff. Participants were treated as full members of TIPS-TOPS. Projects devised include *Creating an accessible learning and teaching environment in the School of Science and Technology*; *Student Mentors in Computing*; *New approach to teaching programming* and *Who killed Clarissa the chicken?* (Impact on staff Section 8.2).

4.5 *Learning Space*

The CELS building is a demonstrable investment in teaching and learning and it has a 'wow' factor! The facilities have a very positive impact on the wider community- with excellent feedback on the CELS building from prospective students at University Open Days. It was also the chosen venue for NTU to showcase itself to a local MP. There is increasing competition for space e.g. in 2008-9, we had 836 bookings all year, whilst in the first half of 2009-10 there have already been 853 bookings. It has expanded the range of learning experiences offered to science students by staff through peer assessment sessions, assessed presentations; final year shows and project posters; lectures, demonstrations, seminars, IT sessions and student society events. In addition, it has proved a highly rated venue for students outside of science as well as for special events, e.g. MA in Museum & Heritage Management exhibition (CELS is the only purpose built exhibition space on site), PGCE science students, outreach activities, medium scale conferences and external events with HEA Subject Centres, regional STEM providers, public lectures and professional bodies.

² These areas were outside original bid remit but became part of College of Science following internal restructuring at NTU in 2006/7

4.6 The Observatory

Innovative approaches to astronomy education for all age groups have brought new audiences in touch with science in addition to academic papers related to *Archaeoastronomy* and *Global Citizenship*.

www.ntu.ac.uk/cels/outreach/Optical_observatory/index.html

Usage statistics per annum are 500 pupils; 1000 attendees at Open Dome events (regular monthly event for the general public of all ages); 50 undergraduate physicists and 120 trainee teachers. (See section 10.3.)



Minibraniacs at the European week of Astronomy

[1092 words excluding table]

Question 5

Have there been any disappointments in how the CETL has developed/what it has achieved. What are they, why did they happen? (600 words maximum)

5.1 Community engagement

The activities and successes of CELS fit exactly with current government strategy (*Higher Ambitions*), engaging the wider community and raising awareness of HE's contribution to society. There has been much local investment in STEM promotion, (the regional development agency is investing £9 million over 3 years in STEM promotion) as well as national STEM initiatives. CELS helped shape these developments, but sources of future funding for such work are not obvious where multiple government departments are involved. At the outset HEFCE deemed sustainability for CETLs to be about changes in practice within HE. However, where models have been validated, continuing activity still requires resourcing. Some charity support is available but mostly targets 'new' projects, not sustaining current excellent practice. This presents a challenge in reconceptualising our current models to meet different needs as well as being creative in seeking funding sources.

5.2 Our TIPS-TOPS model

Whilst highly successful overall in developing staff and resources for student learning, the TIPS-TOPS scheme also carried risks: i.e. it did provide appropriate infrastructure for sabbaticals but could not guarantee that staff would take up projects in the areas outlined in the bids. Three factors that affected its operation were:

- i) Staff did not elect to take the fulltime sabbaticals we proposed – the reason often cited was the upcoming RAE. This was resolved by re-focusing on fractional FTE release sabbaticals and this was highly successful in delivering TIPS projects. There were consequences, however, for the sabbatical holder in trying to balance a range of demands and make steady progress with their projects.

- ii) Certain topics had been included based on expertise within the university – not all the staff involved in the original proposals then elected to pursue sabbatical projects in these areas. To evolve our model, we consulted with CELS management group and the School's Executive Group and then offered additional project areas to support emerging strategic learning and teaching needs and innovation, plus projects in the original areas. The key element here was working with the School's Executive Group to maximise alignment of individual goals with strategic needs. CELS Team members also carried out projects in areas where there were gaps. These had positive outcomes but, consequently, some areas of our original proposal were not studied to the depth we intended.
- iii) The CELS lecturers' scheme was a victim of its own success– a number of these lecturers were so excellent they were appointed to permanent posts before the end of their term. This had consequences for staff changes and occasionally produced gaps in sabbatical cover, as it takes at least 3 months to reappoint. On reflection, this issue was not identified as a risk originally for the project early on and would have benefited from more forward planning.

5.3 Proposed projects that didn't deliver

Not all the areas studied were as productive as originally hoped e.g. the Neural Network system (Loreus Trainer) was trialled in two studies: *Student Learning Styles* and *Development of Resources to Teach Protein Purification (2005-7)*.

- We studied how learning styles affected student use of system (by use of a questionnaire plus tracking which type of learning materials a group of environmental students used on the system). This produced a huge amount of data which was time consuming to analyse. Some results were obtained, (e.g. 50% of students elected to learn visually regardless of their 'learning style'), however the cost-time investment lacked significant benefits.
- The Protein Purification Project was set up to model using the platform with other subjects. Resources were produced and evaluated, but the effort involved was huge and the platform did not deliver all we hoped; it lacked full semantic functionality. Thereafter *Course Genie* and its successor were used to create e-learning resources for our Virtual Learning Environment- mainly in the Bioscience area for a range of students. In 2006, the Protein Purification package was redeveloped and it's been successfully run via our VLE and used by over 900 students in 4 years.

[658 words]

Question 6

Please reflect on the difficult and easier aspects of getting the CETL going and of getting your messages across. For example: Has action/change followed; where and why did you meet success or resistance. What worked, how did you discover this, how do you know it worked? (1000 words maximum)

6.1 Building CELS

For the building programme we had very good support from our Estates department and it was well managed. NTU estates were pro-active from the very earliest stages of the CETL bid; planning permission, site locations, costings per square metre and likely room requirements were all outlined at this stage. Hence, when CELS funding was confirmed plans were well advanced. Where full consultation had occurred, the build was fit for purpose and has produced a high quality venue (sections 1.4, 4.5). We were 'kept in the loop', got the learning space we designed and it has exceeded our expectations. Delays were outside of NTU's hands, [NB 3 months delay when a subcontractor went into receivership (July 2006) affecting the window frames].

We have discovered new uses for the building with major benefits for students, staff, visitors and community. It was opened in March 2007 by Dr. Adam Hart-Davis, media presenter/scientist. The launch attended by the Minister for State for Science and Innovation, and over 100 key individuals had a major impact raising the profile of CELS (and CETLs) through local BBC and radio stations.

Regarding the Observatory, we retained consultants (Green Witch), on the design, location and choice of equipment, and the main telescope was specially commissioned. The architect and builders had not previously designed and built an Observatory. The initial sub-contractor for the dome walls had difficulties (the circular walls had to be reconstructed) and so this extended the capabilities of all our partners. The end-product has been a resource that has been an amazing feature and a visible symbol of commitment to STEM subjects (see section 4.6).

6.2 Human resources & staffing

The HR staff have been fully supportive of our recruitment for CELS. There were a number of unexpected delays in getting posts approved and advertised. The Director of CELS was appointed in April 2005, it took 6 months before the first CELS team started work. The time scale for these appointments was affected by factors including gaps in HR staff at a crucial time and the implementation of the National Framework agreement (posts went through full evaluation processes).

The first CELS lectureships commenced in March 2006, as a result it was not possible to release staff to work on TIPS-TOPS sabbaticals during our first year of operation. Details of our revised plans were detailed in our Annual Monitoring Report to HEFCE. They included the following actions:

- First CELS lecturer started developing TOPS activities e.g. 'Bricks Bananas & You' (DNA Kit in a Kase);
- Employed a short term research associate who then delivered more outreach, [NB gaining confidence from this, she trained as a primary teacher and gained her first teaching post].
- Two members of the core CELS team carried out aspects of our HE projects e.g. designing and running focus groups with students on knowledge gaps and difficult concepts and the use of neural networks to look at learning styles (objectives 1, 2).
- To boost expertise in certain areas the above CELS staff joined the first cohort of the NTU PGDip in Research Informed Teaching which they passed with commendations.
- Undergraduates became involved in SOTL projects

There was also a need for support /CPD opportunities for CETL directors nationally – given the unique challenges faced, such CPD could have usefully been provided by the HEA.

6.3 TIPS-TOPS

For any staff development sabbatical to be effective it needs appropriate scaffolding and management support to deliver what was promised. It cannot be emphasised enough how important good communication with line managers is and their buy-in is crucial to the success of these sorts of development scheme. A particular challenge of engaging academic staff with pedagogic research is that it is an area where experienced academic researchers may have little experience. This affects two areas:

- i. The challenge of developing a 'community of practice' [Wenger]
- ii. An underdeveloped understanding of how students learn.

To help overcome these issues a support team was created with specialists to scaffold staff engagement with TIPS-TOPS. The shift from full time 6 month secondments (with external monthly meetings with evaluators) to part time secondments affected the rate of progress. In order for academic staff to develop their scholarship of learning and teaching, the monthly meetings needed to scaffold their development. Meetings evolved with action learning sets and workshops on planning, reflective logs, evaluation and dissemination. External speakers were invited to show additional perspectives e.g. on getting pedagogical papers published (Papers annexes A,E).

6.4 Outreach

The outreach programme took off like a rocket! A measure of success here is that our school activities were repeatedly taken up by the same school, and our reputation spreads by word of mouth. There was lots of interest and support, working with other outreach groups gave real synergy and brought success. This was the theme of our national workshop (2006) and conference (2008) *Outreach in Collaboration*, over 50

people came to each event showing there is a need for more HE Outreach events in the sector – our work benefits the whole HE STEM sector as none of us knows exactly where the recipients of events will end up. In biosciences there is whole new programme for outreach which is being owned by staff.

6.5 Management Support

The senior management team of NTU and the College of Science fully supported CELS from bid writing to setting up all the financial and governance systems. Senior Pro-VC and two other Pro-VCs are involved in governance of CELS – with chairing and membership of the CELS Management and Advisory Groups. There was support in key areas e.g. getting the website up and working within a short time scale.

Sometimes university wide processes do seem to take a long time and may lack the flexibility to deal with non-standard academic projects. For example, room usage statistics for the university do not count sessions which are non-academic (i.e. not module based), occur out of term time or at weekends which means a wide range of our activities (which deliver key university and government strategies) are excluded from usage data.

6.6 Communication across the institution

In addition to senior management support, we built a broad strategy to inform other parts of the University of our Activities, through website links, newsletters, work with PR officers and articles in university magazines. However, ownership by the broader university community was limited; partly due to our being seen as a science initiative – future projects need to allow for this aspect and be more proactive in building collaborations at an earlier stage.

[1085 words]

Question 7

Has your CETL adopted/used/been based around any specific theories, e.g. of change, or of student learning? If so, what, how have these underpinned your work, have they been useful? (1000 words maximum)

There are several conceptual ideas that have underpinned our activities

7.1 Change management

How do you get academic staff to engage with scholarship of learning and teaching in their discipline? Experience of previous change management models suggested that a mixed model is best – this is where there is a mixture of strategic oversight and direction from the management (in this case from the College of Science and members of the Senior Management Team of NTU) whilst allowing adaption by staff on the ground to fit

local practice. This included adapting the support model. The final cohort of the TIPS-TOPS scheme has prioritised team based projects, addressing strategic changes on a programme wide scale in order to have a bigger added value and impact than the previous model of individual projects. This round of projects include mobile-learning resources for sport lab protocols, a complete programmes wide revamp of the assessment of practical skills in Bioscience, masters provision in chemistry and forensic science plus work on assessment and feedback.

Our model of developing professional practice through TIPS-TOPS has had an impact on individuals and their teams within SST at NTU. In an effort to learn wider lessons for the university from CELS we worked with our staff development specialists (Centre for Academic Standards and Quality and Centre for Professional Learning & Development) to carry out research into different models of staff development schemes. This has been presented internally and externally at SOTL conferences. (*Of what value are academic development projects? A case study of three grant schemes at a single institution in the UK; Boundaries as borders, or margins? Policy, SoTL and developmental schemes; Vehicles for change: developmental schemes, their impact and implications* McNeil, Meredith and Moss). This analysis looked at “What type of development scheme has a good chance of effecting the desired change in a given context?” The evaluation of TIPS-TOPS in 2007 indicated that it gave opportunities to:

- reflect on own practice
- identify gaps in student knowledge and skills
- pursue a pedagogic interest
- access support

However there was pressure on time, specifically:

- local workload issues and tensions between roles
- lack of project risk assessment and contingency planning
- lack of clarity of expectations
- overly optimistic about what participants could achieve
- understanding of real value to individual will only come post-project

Some of the research findings from the comparative study revolve around the gaps that arise between the aspirations of development schemes (like TIPS-TOPS) and their outcomes/impact: We found disciplinary differences that should be taken into account when considering such schemes; discovered that it is likely that something tangible will be produced from the funded projects: an object, a guide, a paper, a module: indeed TIPS-TOPS has led to the production of updated learning materials and new ways of teaching certain subjects; These outputs have all been aligned in some way to the intentions of the schemes, but it can then be difficult to ensure that there is some form of transferability – loosely defined as impact – beyond the individual and their own students. Without further consideration of transference and wider learning from the work, the

ability of the schemes we looked at to impact upon learning and teaching in the institution remains limited.

In recognition of the gap in values/aims: it is likely that these schemes are trying to accomplish too much in attempting to meet institutional and individual aspirations. We are therefore recommending that these two functions are separated out into 2 types of scheme:

- Invitations to tender for specified projects explicitly directed institutional aims
- Development projects shaped by the project holder

We also propose that accountability for delivering a project is owned by all the subject team, so that the team more genuinely protects the time & space needed.

We also propose, that much more support for development projects is offered at the end and after completion. Reflection on the impact of schemes would then be undertaken two years after project end dates.

Strategically the work of CELS also contributed to the NTU report on 'Scoping Pedagogic Research at NTU' which looked at pedagogic research development and support at NTU and its relationship to awards and titles/promotion schemes and is informing future developments in this area. It is also contributing to university plans for a pedagogic research submission to REF2012

7.2 *Threshold concepts and troublesome knowledge*

Work on objective 1 on conceptual difficulties within science led to engagement with recent theory: *Threshold concepts and Troublesome Knowledge*. This became a theme that underpinned our work, and was applied to areas in chemistry, forensic science, sport psychology and physics. We identified certain concepts that are Threshold Concepts – the challenge emerging for the whole model nationally is, 'Having identified certain science concepts as Threshold Concepts what do we do about teaching them more effectively?' We have produced a number of conference papers for national and international events in this area as well as student projects and are currently looking at how to address such concepts going forward. [Annex A]

7.3 *Constructivism for effective learning*

Applying existing models of Context-Based Learning(CBL)/Problem-Based Learning(PBL)) to develop new materials was a core CELS objective. This was embedded within our activities for both HE and Outreach, where we adopted a constructivist inquiry based learning approach as the cornerstone of our pedagogical ideology. This is exemplified by materials for schools including *Chemical whodunit- murder at the university; Forensic Microbiology; and Physics for Forensics*; whilst for HE case studies and practicals for Criminalistics and Environmental Science were developed and used.

7.4 Collaborative models for Outreach

Throughout we adopted a model of 'Outreach in Collaboration' [NB by working together the sector can achieve a synergistic impact on inspiring young people to study science /consider entering HE, hence recruitment across the sector]. This model is now at the centre of the latest HEFCE funded national HE STEM programme. Our model goes beyond 'sharing best practice' to joint working (at a range of levels) with the East Midlands CETL Network, HEA Physical Science & Biosciences Subject Centres, ASE, professional bodies (RSC, IoP, IoB), local schools & colleges, Aim Higher, [Annex G List of partnership events] other STEM organisations – BA, East Midlands STEM partnership, Nottingham Science City and EUSCEA (European Science Events Association). This partnership with over 50 collaborative events with 10 organisations has increased capacity to reach more young people in a more effective way.

[1064 words]

Question 8

Reflecting on the last five years what other important messages are there that you want to convey about your CETL - its successes, difficulties, impact etc. (1000 words maximum)

8.1 Measures of Success

These are based on quality of interactions and the numbers of people affected. Successes include defining models for: effective learning; staff development for academic staff and school teachers, and collaborative working in Outreach.

Supporting examples:

- Our impact on young people regionally has been significant (over 26,500 interactions from 770 school bookings from 430 different schools). Our activities are innovative and effective. Evaluation consistently shows teacher ratings of Kits for content, level of science, style & quality as rated very good /good (ie scoring 4/5 or better on a Lickert scale) Areas of note included "*Clear explanations of a difficult area of science which non-scientific class teacher would find difficult*"; "*The hands-on approach*";
- Staff have benefitted both from sabbatical opportunities (TIPS-TOPS) and CELS lecturers. We have refined and used innovative processes for managing and developing individuals involved with TIPS-TOPS. The impact has gone beyond the learning innovation itself. In some cases, it reinvigorated the person's career, (section 8.2);
- Influencing models of teacher training at NTU through the quality of our methodology with invitations to train new teachers in our approach. This gives us a permanent legacy in terms of the young people each teacher will meet in their professional lifetime; e.g. this year we training all NTU BA Primary Education

- students in our Kit in a Kase methodology. (Requested by their programme leader, who had experienced our Kits whilst himself a primary school teacher);
- Other teacher training includes sessions on *How to do 'Chemical Demonstrations (Surely that's Banned)'*, *Creation and Use of 'Enhanced Microsoft PowerPoints'*, workshops on *'Teaching with Simulations and Models'* and *'Real Data to support Data Handling Skills'*;
 - Science-Art resources – ICARUS, COSMOS, Exhibitions, *'Come alive to Science'* work with education & art on overseas summer camps;
 - External esteem is building through Memorandums of Understanding (MOU) with two Korean organisations; being invited partners for EU FP7 bids; and European invitations to present on voting systems and outreach;
 - Developing flexible activities for non-standard learning environments: home-schooled learners; children in hospital; teenage mothers; scouts & brownies as well as the learning disabled.

8.2 Tales of CELS- an indicative case study of CELS activity

'Clarissa the Chicken' pilot master class: Aim is to inspire school children regarding land-based studies, as many are unaware of this area. This team-based practical exercise for students, backing up ideas with scientific evidence, involves problem-based learning, and sessions give a taste of university life at the Brackenhurst Campus. The activity is now embedded and 5 new master classes are being developed. The staff member (HC) feels that an important part of the embedding has been within themselves and the way in which they now teach having done their TOPS project. The activity was adapted for use with Brackenhurst students. The project has affected other staff, providing an impetus to develop other master classes, e.g. in Equine Studies, Sports Science, Forensic Science. There is also potential for commercialisation of this activity. HC has disseminated the outcomes of the project through CELS workshops and seminars and to her School Executive. Beforehand HC had never done a teaching project or presented at learning and teaching conferences. It is obvious that doing a CELS sabbatical has given HC a whole new passion for teaching. HC is now a university *Champion of Academic Enterprise*.

Student Ambassador Scheme JH developed this scheme which includes mentoring for students by students. The enjoyment gained from this project led to involvement in a second team project. JH successfully disseminated outputs at internal and national teaching and learning conference papers. JH indicated how enjoyable they found these events. *'Unlike subject-based events where there was likely to be only certain specific aspects of interest, at learning and teaching events almost everything on offer was potentially useful and of interest'*.

8.3 Partnership with Royal Statistical Society's Centre for Statistical Education (RSSCSE)

Activities to promote STEM were co-delivered with RSSCSE, developing resources (14 experiments and 4 teaching tools, including a mixture of novel activities plus adaptations of 5 existing resources for *Experiments at School*, www.experimentsatschool.com). Science-based experiments include *Candle Combustion* (Chemistry), *Reaction Timer*, *All About Me* (collecting data on genetic traits), *Colour Maker* (Physics). The databases are sampled using an innovative data interrogation tool we developed, allowing rapid analysis of large random samples and opportunities for hypotheses testing. Other joint projects are *Hand on a Plate* Kit and online surveys of first year undergraduates. In 2009, the move of the RSS centre to another university caused some technical disruption but has not impacted significantly on website development; staff collaborate to ensure continuity of this resource. Two conference papers on recent developments (2009-10) produced by the CELS Team will be presented at the International Conference on Teaching of Statistics, Slovenia, July 2010).

8.4 Dissemination

CELS dissemination strategy has multiple methods, functions and audiences. [Table 3 matches audiences for dissemination to methods used, details Annex H].

The functions of dissemination are

- 1) Raising awareness of our purpose and goals
- 2) Developing understanding within the HE community
- 3) Creating responses that result in changes in working practice of staff, (which impacts on students)
- 4) Creating longer term change within the subject area, institution and the HE sector.

Whilst awareness and understanding of our work is strong amongst those staff who interact with HEA Subject Centres, outreach organisations, local media, community and European organisations; our external evaluator identified limited awareness amongst external HE science staff of our work. On reflection a programme of strategic departmental seminars in other HEIs would have helped.

Throughout we have striven for higher impact -going beyond talking and writing about activities- to change practice. Hence, our adoption of experiential learning approaches e.g. workshops/hands-on sessions at conferences. Adoption of our approaches by teachers and other academics as well as invitations to talk about our work implies our dissemination strategy is delivering (1)-(3) and partially (4). Longer term benefits are only now beginning to become manifest (our final round of TIPS-TOPS projects is still to complete).

We have encountered challenges in applying outcomes across the university, as developments are seen as discipline based. Presentations made at key NTU wide events and to other subject areas, have led to joint projects and positive feedback, but

systematic take up of outputs has been minimal. We are seeking to address this through continuation planning for CELS' legacy within NTU (see section 11).

Table 3 Map of audiences to mode of dissemination

| Audience | Website | Leaflets | Newsletter | Workshop | Conferences | Publications | Activities TIPS-TOPS | School Presentations (NTU) | East Midlands Fora | Outreach activities | Communicating S&T Module | Talks to Senior Management | Media events |
|--|---------|----------|------------|----------|-------------|--------------|----------------------|----------------------------|--------------------|---------------------|--------------------------|----------------------------|--------------|
| Staff at NTU across disciplines | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | | | | | ✓ |
| Senior management of university | ✓ | ✓ | ✓ | | | | ✓ | | ✓ | | | ✓ | ✓ |
| Students | ✓ | ✓ | | | | | ✓ | | | ✓ | ✓ | | ✓ |
| HE Staff nationally | ✓ | | ✓ | ✓ | ✓ | ✓ | | | | ✓ | | | ✓ |
| Special interest groups (SIGs) | ✓ | | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ | | | |
| Educational development centres | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | |
| HEA Subject Centres | ✓ | | ✓ | ✓ | ✓ | ✓ | | | | ✓ | | ✓ | |
| Thematic academic practice groups | ✓ | ✓ | | ✓ | ✓ | ✓ | | | | ✓ | | | |
| International groups: academic practice/cognate area | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | | ✓ | | | ✓ |
| Professional bodies and learned societies | ✓ | | ✓ | ✓ | ✓ | ✓ | | | | ✓ | | ✓ | ✓ |
| Local communities | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| Regional STEM groups | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ |
| Other CETLS | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ | | | ✓ |

True measures of impact (4) require baseline data to be collected initially; where ideas and activities have evolved, this approach is not feasible. Some highly desirable measures –the impact of a single outreach activity on the career choices made by a young person - are not measurable – too many factors are involved to allow quantification of a single variable. We looked very closely at what impact means for a CETL via a deeper engagement with theory - it is apparent there is a lot of uncertainty over impact measures. (See section 10.2).

[1146 words]

Question 9

Reflecting on the last five years what important messages are there that you want to convey about the experience of being part of a wider 'movement'/experience of other CETLs. (600 words maximum)

9.1 Regional Networks

There have been definite achievements through local CETLS working together through the East Midlands CETL Network. The emergence of the East Midlands CETL network was an unexpected outcome but has proved a very useful support group for all those dealing with the complexity of running a CETL, including Directors. It allowed us to hold a joint launch of the initiative (1st June 2006) and to capitalise on synergies and developments of each CETL e.g. around Outreach. Joint work allows for more efficient activities and led to partnerships for other work e.g. GENIE & CELS held joint Bioscience outreach for schools from Leicester & Nottingham; we then became partners in a European FP7 bid with EUSCEA (2WAYS, where CELS & Genie CETL are working with a Irish science education and outreach centre at University of Waterford, (CALMAST) on a science communication project). The East Midlands group also hosted the 2008 Annual CETL conference at Leicester (with the HEA). This event with its focus on CETL issues such as Impact, Dissemination and Sustainability provided stimulated valuable ideas across the initiative, and in our case, an invitation to lead a workshop on impact from another CETL in a completely different cognate area. In addition we have been members of each others advisory/ governance groups to share best practice. This has been a best practice model for the wider CETL initiative.

9.2 HEA interaction

In terms of interaction of CETL initiative with the HEA there are two stories to tell – one around central/generic HEA and the second around HEA Subject Centres.

9.2.1 Central HEA support:

There were some useful workshops at the initial stages of CETL development which helped develop ideas and models, but support for the CETLS recently has been very limited. One consequence of this has been a lack of multiplier effects from the whole initiative. In order for staff to gain as much as possible from their CELS TIPS-TOPS sabbaticals they needed a supporting scaffold – there was little evidence that HEA York sought to scaffold the whole CETL initiative in such a way as to draw lessons and optimise gains by the whole sector. The most useful HEA activity has been their central CETL JISC-mailbase which has helped to advertise our activities to each other and across NTU.

9.2.2 HEA science based Subject Centres

We continue to have excellent links with these centres, helping to develop links with other science-based CETLs. Collaborative working with the HEA Subject

Centres has included co-organised/co-sponsored events e.g. National Science Learning and Teaching Conferences (organised by Centre for Bioscience, Materials and Physical Sciences Subject Centres in 2005, 2007, 2009) as well as chemistry education(VICE)/physics education(PHEC) national teaching conferences. Our Outreach in Collaboration workshop (2006) and conference (2008) were held jointly with the Physical Sciences Subject Centre and GENIE CETL. The Physical Sciences Subject Centre disseminates newsletters and with Biosciences Subject Centre are members of the CELS Advisory Group.

9.3 Other STEM networks

In support of government strategy to support strategic and vulnerable subjects CELS has engaged pro-actively with both Chemistry for our Future (running a curriculum development project on C/PBL as well as outreach activities) and Stimulating Physics where CELS has linked to both the teacher networks in activity design and hosted a physics teacher fellow from January – August 2008. This produced a conference paper at the Physics Higher Education Conference 2008 in Edinburgh on *Student Attitudes to Physics at School & University*.

Local initiatives also offered *Strategic Added Value* to what we do through the medium of East Midlands STEM Partnership. These improve the local STEM profile and levered support from the RDA (emda). The impact of a joined up approach reached local industries and covers all ages of education and training, similar work is undertaken by the Nottingham Science City Education & Training group.[633 words]

Question 10

Please reflect on work emerging from your CETL that has been 'transferable', i.e. useable beyond the home audience for which it was originally developed. (You may wish to comment in terms of materials produced, a community created, understandings that CETL work has illuminated and which are useful to others, etc) (1000 words maximum) It would be useful to hear 'messages' and lessons learnt that you would like to continue to be disseminated.

10.1 Community engagement

Our pattern of community engagement with collaboration, innovation, and our outreach coordinator, provides the new HEFCE HESTEM Project with cutting edge best practice in how to work with schools, across the city and region with proven effective activities. We also offer to HE models of outreach that engage with non-standard sectors eg home learners and hospital educational units. Kit in a Kase is an exemplar for a range of primary teaching and offers a new way for HE to engage with primary schools in line with the aims of *Higher Ambitions: "Local engagement is also crucial to the university function of extending access to higher education among social groups and in areas where it is unacceptably low"*.

10.2 Impact models:

The differences between input, activity, outputs, outcomes and impact – presented at Annual CETL Conference, March 2008, workshop for Middlesex CETL (June 2008) and the paper *What is effective learning in science? Impact and Outcomes from a CETL*, New Directions in Physical Science (2009). All funders want to see ‘impact’ for their investment but few people know what ‘impact’ means. Mostly what is quoted as ‘Impact’ is actually ‘Activity’ or ‘Outputs’ other parts could be ‘Outcomes’. Using research from the social and voluntary sector on impact (Wainwright³) gave the definitions in Table 4: I have interpreted the definitions to fit the CETL initiative, noting that *Outputs* are about *effort* whilst *Impact* is about *change*. The results are shown in Table 3, which has formed the basis of workshops on Impact for the CETL community. It is worth considering such concepts for any educational or research project.

Table 4: Impact Measures for CETLs adapted from Wainwright

| Concept | Definition | Examples in a CETL context |
|-------------------|--|---|
| Inputs | Resources invested in the CETL | income, staff, volunteers and equipment |
| Activities | What we do with our inputs to achieve our mission/goals | training, research projects, learning developments, designing learning spaces |
| Outputs | Tangible/countable products of a CETL’s activities (not objectives) | sessions held, papers written, space utilised, training delivered, development schemes, student learning interactions, buildings and equipment used |
| Outcomes | Benefits/ changes to people from the activity. Usually longer term, (less tangible), planned and based on CETL objectives | improved student learning, raising achievement, changes in staff practice, staff promotions, institutional change |
| Impact | All change resulting from a CETL- includes: intended & unintended effects; negative & positive; long-term & short-term effects | regional partnerships, aspirations raised, interdisciplinary projects, sustainability and embedding of core ideals |

The diversity and scale of our audiences makes mapping the impact of CELS more complex than for some CETLS. Given the size of our school based audience, tracking of the outcomes of all our activities is a major research project in its own right as it includes primary, secondary and tertiary education within the UK, Europe and beyond. [NB our web site stats show our resources being accessed by people in XXXXX countries [Annex I].

³ Wainwright, S.(2002) *Measuring Impact - A Guide To Resources*,[online] National Council for Voluntary Organisations, 2005-7. Available <http://portals.wi.wur.nl/files/docs/ppme/measuringImpact20012003.pdf> [Accessed 14th August 2009] & The UK Voluntary Sector Research Group. (2003) *Case-studies of impact assessment in small and medium-sized voluntary organisations* Available <http://www.ncvo-vol.org.uk/asp/uploads/uploadedfiles/1/456/measuringimpactreport.pdf> [Accessed 2nd June 2009].

10.3 The Observatory

The impact of this facility built with the extra capital has exceeded all expectations. Innovative approaches to astronomy education for all age groups has brought new audiences in touch with science as well as academic papers related to *Archaeoastronomy* and *Global Citizenship* (D. Brown, N. Neale & R. Francis, *Archaeoastronomy Summerschool: A Case Study*, 2010, in prep.).

The facilities were successfully integrated into undergraduate teaching at NTU resulting in students exploring cutting edge research fields (e.g. in the field of extra-solar planet and near-earth object observation), not previously thought to be accessible for practical work at undergraduate level.

To allow students/pupils to assist and carry out research at this facility three bespoke placement profiles have been created in the past year, attracting: 5 yr 10/11, 2 post-16, and 1 FdSc student placement students per year.

Additionally, the observatory has provided a hub for monthly *Open Dome* outreach events for the general public (all ages including families). Such local engagement is very positive in further developing the University's profile. We now have an audience of nearly 1,000 people per year and have widened our offer to include specialised events supporting staff families in the holiday season (these are always oversubscribed by 300%).

Moreover, the observatory offers 1-2 hour astronomy activities and master classes for schools (KS1-KS5) and community groups (cubs, scouts, and WEA). The most popular activity "Everything you want to know about the Moon..." has run seven times in the last year targeting at least 200 pupils.

Additionally, we have developed an innovative activity including modern projection equipment (D. Brown & N. Neale, *A Global Citizen of the Sky*, BESA 2009, submitted) that has been carried out 9 times in the past year, targeting more than 150 pupils (KS2-KS3). The application has proven so popular that this activity is also included into the Primary BA, PGCE primary and secondary teacher training and has targeted more than 120 trainee teachers.

Total numbers per annum are 500 pupils; 1000 attendees at Open Dome events; 50 undergraduate physicists and 120 trainee teachers.

The astronomy officer is funded by the HEFCE SIVS (Strategically Important and Vulnerable Subjects) funding – so we have combined CETL funding with SIVS funding to gain significant added benefit for promoting STEM subjects.

10.4 Models for staff sabbaticals

Lessons learnt applicable to the sector include 'change management' (section 7.1) this is about beginning to build a community of practice. There are 'Tales of CELS' accounts of journeys people have taken through case studies (in preparation). Mostly, outcomes for staff were proportional to how much they engaged with the process – those who took up all the opportunities (time, space, support groups, workshops) gained most and usually got publishable outcomes from it. However in lessons for future sabbatical schemes they also said it was important that *"your School provides an explicit commitment to provide time for you to do the project"*; and that you *"perform a risk assessment of the proposed project before you start."*

Some TIPS-TOPS members who had extensive research experience and who attended national Science Learning and Teaching Conferences to present their work were impressed as to the difference in atmosphere of a pedagogic event compared to that of a subject-based research conference. They commented on how much they had learnt by attending, as well as gaining ideas to share with colleagues.

10.5 The crossing of boundaries

Interdisciplinarity: working across subjects has proved beneficial to both parties with academic research as well as subjects - papers on drama education from COSMOS & ICARUS (Annex A, E), new partnerships and markets for NTU science education.

Crossing cultural boundaries: The transferability of our approach to other countries talk given at the recent ASE international conference by Prof Ireson in Jan 2010 using CELS examples eg 'Liquid Rainbows' and sharing best practice at international events Norway, Sweden, Italy, Portugal and Korea [Annex H]. CELS work has also impacted on classroom practice with teachers and pupils externally with workshops on our approach to science festival organisers from the Norwegian Science Research Council and Swedish chemistry teachers.

10.6 New applications of interactive technology in education

Our work on interactive Adobe®Flash®-based animations and voting systems has led to papers presented at the international Interactive Technologies and Games Conference (2008, 2009)

[1052 words]

Question 11

How will the work and achievements of your CETL continue after HEFCE funding ends (1000 words maximum)? Please reflect on how far you think CETL work has become embedded in your institution or discipline and indicate if any structures have been put in place to ensure its legacy is not lost (1000 words maximum)

All aspects of CELS work are being subjected to a systematic and critical review in terms of their longevity and usefulness to strategic direction within NTU at both discipline and university level. As a result the following approaches for continuing the work and achievements of CELS are underway:

11.1 Embedding of enhanced practice

As originally envisaged for the CETL initiative, outputs of completed TIPS projects have been evaluated and successful innovations in teaching and learning have been embedded within programmes (eg flexible MSc Bioscience modules, green chemistry and forensic science practicals, Communicating Science & Technology module. As a team leader said *“All of the developments have continued beyond the project end date exhibiting excellent value for the investment”*.

A particular development here is working with the science-based partnership managers for university's Schools Colleges and Community Outreach team to deliver a range of competitions and events for 14-19 year old market: TOPS outreach developments for secondary schools are being taken up as part of the programme offered to schools through the academic members of the School of Science and Technology, e.g. Master classes in Green Chemistry, Astronomy and Biosciences

11.2 Commercialisation and sponsorship

In addition, aspects of CELS work which have commercial potential are being exploited in a developing business plan, e.g. commercialisation of activities for primary schools (Kit in a Kase), e-learning resources for schools and Teacher CPD being explored. [NB without other funding primary outreach is not sustainable at its current level]. We have recently hosted a staff member for three months from KOFAC – the Korean Organisation for the Advancement of Science and Creativity to explore how KITS and other activities could be adapted for South Korean market [NB NTU has signed an MOU with KOFAC who run national STEM promotion events and schemes from teacher CPD to science clubs and science ambassadors.]

11.3 Repository of outputs

Internally positive steps are being taken to leave a legacy for the institution and discipline once CELS HEFCE funding has ceased. This can be viewed in a number of ways from the material to the philosophical:

- As indicated above resources and modules developed will continue in use and to impact on students e.g. portfolio project on assessment of practical skills is a long term investment in the future employability of bioscience students and has potential to offer the sector a model of innovative good practice over next 4-5 years.
- We are working with the Institutional Repository(iREP) team to put up case studies and project outcomes into iREP so that both NTU and the wider sector can continue to benefit from our work

- As part of the JISC funded NTU internal Learning Repository Project we are adding learning resources in a range of formats – these can then be drawn down into a wide range of programmes across NTU, by staff from different discipline areas.
- More recently the new HEA Evidencenet resource offers another repository for CETL outputs like ours and discussions are underway.

11.4 Capital resources

The CELS building will continue to be a high quality learning space, much in demand for its flexible rooms and external facing applicability. The Observatory is now embedded in courses, school activities and public engagement events. Other equipment and facilities will continue to be used within the areas they were provided for. Lessons learnt from the build were fed forward into future building developments.

11.5 Dissemination across the sector

As discussed in section 8.4, throughout its lifetime, CELS has taken a proactive approach to dissemination. Our aim was to foster changes in practice within the subject area, institutional academic practice and the HE sector. A number of these dissemination activities will have a longer term ‘footprint’. In addition to presentations and papers at internal, regional, national and international events (science learning and teaching conferences, outreach in collaboration events, European conferences, Korean Science camps and exchanges); articles have been published and wherever possible our approach shared through hands-on workshops e.g. Variety in Chemistry Education, Outreach in Collaboration, teacher CPD sessions running alongside outreach events, trainee teachers sessions, (Annex H). Our website has also offered resources for schools which can be used over the internet or downloaded. We have had requests for copies of resources eg synthesis and spectroscopy teaching sessions, copies of Kit presentations, access to Flash files on moles and the use of *Molecular Geometry* resources globally. In addition putting learning assets into the Learning Repository will facilitate re-use and development, and facilitate wider dissemination via national Open Educational Repositories.

11.6 Impact on people

One area for longevity is the impact on the people employed through CELS approaches e.g. CELS lecturers who say:

“Simply put this has been an overwhelmingly positive experience for me. I feel a much more confident lecturer, with a much greater understanding of the pastoral and administrative responsibilities.”

“I have had the opportunity to study for a PGCHE and have received a distinction grade for all course work handed in so far. More than just studying for a qualification, this has allowed me to evaluate and reflect upon my teaching and so inform and improve my lectures and seminars.”

“The experience I have gained in the past year as a CELS Lecturer ...has helped to establish a broad and solid base in my teaching activities from which I have developed teaching and learning material in a diverse set of subject areas including biochemistry, molecular biology, immunology, pharmacology and neuroscience.”

“Furthermore, as a Year Tutor for Level 2 students, ..., I feel that I have gained a very good working relationship with students understanding the importance of clear delivery, enthusiasm, approachability and creating an inclusive and challenging learning environment.”

[940 words]

Question 12

Do you think there are any emerging aspects of your CETL activity that will have greater importance in the future? (600 words maximum)

12.1 Nationally

Lessons learnt in developing outreach activities, promoting STEM and coordinating regional developments in the STEM skills and training agendas can be applied nationally within the wider government STEM initiative and the new HE STEM programme. Our work is delivering on aspects of the government’s *Higher Ambitions* framework concerning better partnership working between universities, business and regional development agencies, support for Strategic and Vulnerable Subjects, alternate routes into education & training, Widening Participation, careers advice and Community Engagement.

For example:

- Getting young people and adults interested in STEM will continue to be an important issue as demographics affect the 18-21 population profile. There is a growing need to re-engage adults with education and training – up-skilling the workforce. This affects work such as CPD, non credit bearing training, careers advice, part-time education and Foundation Degrees.
- Our work in engaging students with schools through the Communicating Science and Technology module (UAS scheme) is a model that should be maintained and expanded. With its work-related learning placements, development of employability skills, contribution to the community, opportunities to raise aspirations and share their passion for their subject this model directly supports current government agendas. Volunteering opportunities in outreach work also contributes much to the individual and the community.
- Coordinated approaches to outreach have been highly effective through working with other HEIs, professional bodies and local funded STEM initiatives. It is more efficient to have the admin for one coordinated event than 4/5 separate ones.
- It is also more effective to influence the classroom practice of the science teacher (and hence every pupil they ever teach)– increasingly Outreach work should

include a profile of teacher CPD activities especially those that contain STEM subject knowledge, ‘training the trainer’ is the way forward, and we are developing partnership working with the Science Learning Centres.

- Curriculum development – the use of Inquiry-based learning both within HE and school curricula is a major factor in building the skills set for both research and industry – a recent CBI report points to the need for these.
- Work in both European and Korean arenas show the potential to develop markets overseas and bolster international recruitment to UK programmes and CPD courses.

12.2 Internally

There are a range of markets to consider internally: supporting academic teams with learning and teaching developments; community engagement activities and developing the individual.

- E-learning/blended learning /flexible delivery (lessons from TIPS Bioscience projects) as a model for such programmes across institution.
- Use of technology in improving learning in new areas such as mobile learning platforms.
- An area of growing interest is in collaboration between discipline areas e.g. joint projects with education (teacher CPD and innovative ‘minds-on’ approaches to teaching science) and art (sci-art, creativity). Increasingly projects involving aspects of cultural studies -global citizenship, creative writing/poetry.
- Portfolio assessment for practical skills (TIPS-TOPS project 2009-10) approaches as these feed directly into the growing skills for employment agenda.
- The TIPS-TOPS sabbaticals have been shown to add value to the academic teams who experienced them – there is a desire to find new ways to support sabbatical activity going forward. [517 words]

Question 13

Any other comments (600 words maximum)

13.1 Impact on subject teams in Science & Technology

From a management perspective the team leaders say:

“Elevated capacity and support for staff to actively engage in research focused on enhancement of the student learning experience, as well as developing innovative methods of delivery, have greatly impacted on the Team.”

“Specific projects, examining assessment of large groups, script reading tools and effectiveness of live-projects for student employability, have all had an influence on the working of the Sports Team. Changes have taken place across the Team with regards to assessment of students work as to improve timeliness of student feedback. Use of assessment grids and matrix as devised through GS’s work has

enhanced assessment strategies in a manner that enables feedback on students work to feed-forwards in their preparation of future assessments."

"Implementation of learning approaches that increases student employability has increased the level of engagement with employers across the Department"

"The TIPS-TOPS projects have been very useful to pump-prime initiatives that might otherwise have struggled to get off the ground."

"A focus has been on developing inter-year activities which have complemented course teaching and also helped with the level of fulfilment and support felt by many students. The other projects have involved enhancing teaching and assessment methods. They have been very successful at helping to teach difficult concepts in motivating ways."

"CELS funding in Biosciences has provided support to enable staff to carry out projects ranging from production of e-learning materials to overhauling our outreach activities. This has had tremendous impact on allowing launch of our MSc Biomedical Science by flexible learning (using modules developed with CELS funding), launch of a short course for CPD in bioinformatics, producing exciting interactive learning tools for UG students, organisation and development of new outreach activities, with a programme of events and liaison through CELS to achieve this".

"On balance, therefore, the CELS experience has been hugely beneficial to the Team on many different levels all of which has improved the learning experience of students, prospective students, academics and staff."

"The staff also gained a valuable developmental experience benefiting from the mentoring provided by the scheme and from the exchange of good practice and group learning that it facilitated."

"The CELS lecturers themselves have been an enormous asset to the Team. Three of the post-holders have secured full-time lecturing posts with us, and it is likely that the fourth will as well. Their enthusiasm for teaching is apparent, and they have all contributed to highly successful outreach activities and to student recruitment. One has presented at a national conference (British Association of Science 2007), and many of the CELS sabbatical outcomes have been disseminated via the University Learning and Teaching Conference, and the School Learning and Teaching Conference"

13.2 In conclusion

CELS has been a great opportunity that has enriched lives, enhanced the student and staff experience and given people a passion for their work. Everyone (the core team, TIPS-TOPS, CELS lecturers) has acquired expertise way beyond what they could have done in previous roles. We have invested the money awarded to the benefit of 'UK HE' - enriching education, stimulating excellent practice and building processes for the future which will continue to benefit the institution, the academy and external communities.

[538 words]

Annexes

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Glossary

| | |
|--------------------|---|
| ARES | School of Agricultural Rural & Environmental Studies at NTU |
| ASE | Association of Science Education |
| AV | Audio-Visual |
| BSA | British Science Association (was BAAS) |
| CELS | Centre for Effective Learning in Science |
| CETL | Centre for Excellence in Teaching & Learning |
| CPD | Continuing Professional Development |
| C&T | Computing & Technology team |
| EDT | Engineering Development Trust |
| FEEL | Effective Feedback for Enhanced Learning |
| <i>Emda</i> | East Midlands Development Agency (Regional Development Agency- RDA) |
| EMSTEM Partnership | East Midlands Science Technology Engineering and Maths Partnership |
| FdSc | Foundation Degree in Science |
| FDTL | Fund for Development of Teaching & Learning (a HEFCE initiative) |
| GENIE | Genetics CETL at University of Leicester |
| HEA | Higher Education Academy |
| HEIs | Higher Education Institutions |
| ILTES | Institutional Learning & Teaching Enhancement Strategy |
| IOB | Institute of Biology |
| IoP | Institute of Physics |
| KiaK | Kit in a Kase |
| KS1, KS2, KS3, KS4 | Key stages in primary & secondary education, KS1 Key Stage 1: 5-7 years KS2 Key Stage 2: 7-11 years KS3 Key Stage 3: 11-14 years KS4 Key stage 4: 14-16 years |
| MOU | Memorandum of Understanding |
| NSC | Nottingham Science City |
| NTU | Nottingham Trent University |
| PGCert HE | Post Graduate Certificate in Higher Education |
| PRS | Personal Response Systems (NB voting handsets) |
| RAE | Research Assessment Exercise |
| RSC | Royal Society of Chemistry |
| RSSCSE | Royal Statistical Society Centre for Statistical Education |
| SOTL | Scholarship of Learning & Teaching |
| SST | School of Science & Technology at NTU |
| TIPS-TOPS | Teams for Integrated Projects in Science Teams for Outreach Projects in Science |
| UAS | Undergraduate Ambassadors Scheme |
| VLE | Virtual Learning Environment |
| VR | Virtual Reality |
| WP | Widening Participation |

Annex A: List of Peer reviewed outputs and other outputs

Peer reviewed papers and conference papers

2010

1. Brown, D. Neale, N., 2010. A Global Citizen of the skies. *Educational Futures*, 2 (2), pp.41-55.
2. Ireson, G., 2010. Crossing cultural boundaries: Minds-on Science. [International workshop] *ASE Conference*. Nottingham, UK, 6-9th January.

2009

3. Moss, K., 2009. What is effective learning in science? Impact and outcomes from a CETL, *New Directions in Physical Science*, 5, pp40-47.
4. Crowley, M. Moss, K., 2009. Using personal response systems for effective learning, *Interactive Technologies and Games: Education, Health and Disability conference*. Nottingham, UK, 25-26 October 2009.
5. Forsythe, S., 2009. Putting the BIO into Bioinformatics. [Poster] *Proceedings of 3rd National Science Learning & Teaching Conference*. Heriot-Watt University: Edinburgh. UK, 16-17 June 2009.
6. Hartley, J., 2009. Student Ambassador Scheme. [Paper] *Proceedings of 3rd National Science Learning & Teaching Conference*. Heriot-Watt University: Edinburgh, UK, 16-17 June 2009.
7. Neale, N. Moss, K., 2009. Science targeted recruitment—not just for post 16. [Poster] *Proceedings of 3rd National Science Learning & Teaching Conference*. Heriot-Watt University: Edinburgh, UK, 16-17 June 2009.
8. Crowley, M., 2009. Data analysis Tool. [Poster] *Proceedings of 3rd National Science Learning & Teaching Conference*. Heriot-Watt: Edinburgh, UK, 16-17 June 2009.
9. Martin, P. Moss, K., 2009. Developing a 21st Century Curriculum for Science: Context-based Learning Resources in chemistry at NTU, *Proceedings of 3rd National Science Learning & Teaching Conference*. Heriot-Watt University: Edinburgh, UK, 16-17 June 2009
10. Rumney, P. Scrivens, N., 2009. ICARUS - the ethics of Stem Cell Technologies for GCSE students, *International Science in Society Conference*. Cambridge September 2009.
11. Moss, K., 2009. Communicating Science: Engaging Students, *Proceedings of EuroVariety in Chemistry Education*. Manchester, 2-4 September 2009.
12. Taylor, P. Moss, K. Ayres, R. Cousins, G., 2009. Non-traditional students' experience of learning physics and chemistry, *Proceedings of EuroVariety in Chemistry Education*. Manchester, 2-4 September 2009.
13. McNeil, J. Meredith, A. Moss, K., 2009. Mind the gap: Bridging individual and institutional aspirations for learning. [Paper] *Annual University Learning and Teaching Conference*. Nottingham Trent University: Nottingham, UK 30 April 2009.

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14. Knowles, J. Moss, K., 2008. Why students stop studying Physics. [Paper] *Proceedings Physics Higher Education Conference*. University of Edinburgh: Edinburgh, UK 4-5 September 2008.
15. Martin, P. Moss, K., 2008. The Shape of the Chemistry Curricula in 2008. [Paper] *Proceedings Variety in Chemistry Education Conference*. Dublin City University: Dublin, Ireland 28-29 August 2008.
16. Hartley, J., 2008. Using student ambassadors to aid retention of first year students. [Paper] *Annual Learning & Teaching Conference*. Nottingham Trent University: Nottingham, UK 3 April 2008.
17. McNeil, J. Meredith, A. Moss, K., 2008. Boundaries as borders, or margins? Two aspects of developmental schemes. [Paper] *International Conference of Scholarship in Teaching and Learning (SOTL)*. London, UK 15-16 May 2008.
18. McNeil, J. Meredith, A. Moss, K. 2008. Vehicles for change: development schemes, their impact and implications. [Workshop] *Proceedings Higher Education Academy Conference*. Harrogate, UK 1-3 July 2008.
19. Rumney, P. Scrivens, N., 2008. ICARUS - the ethics of Stem Cell Technologies for GCSE students. [Paper] *IX-World Congress on Bioethics*. Croatia, August 2008.

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20. Moss, K. Greenall, C. Rockcliffe, A. Crowley, M. Mealing, A., 2007. Threshold concepts and troublesome knowledge in chemistry. [Paper] *Proceedings of Variety in Chemistry Education Conference*. Leicester University: Leicester, UK 30-31 August 2007.
21. Moss, K. Mealing, A. Westbrook, G. Tang, S., 2007. Kit in a Kase: Outreach activities for all. [Workshop] *Proceedings of Variety in Chemistry Education Conference*. University of Leicester: Leicester, UK 30-31 August 2007.
22. Moss, K. Greenall, C. Rockcliffe, A. Crowley, M. Mealing, A., 2007. Threshold concepts and troublesome knowledge in chemistry. [Paper] *Proceedings 2nd Science Learning and Teaching Conference*. Keele University: Keele, UK 19-20 June 2007
23. Rockcliffe, A. Greenall, C. Moss, K., 2007. Threshold Concepts, Troublesome Knowledge and Knowledge Gaps. [Poster] *Proceedings 2nd Science Learning and Teaching Conference*. Keele University: Keele, UK 19-20 June 2007.
24. Greenall, C. Bonner, P. Beattie, R. Moss, K., 2007. Learning Styles – is what students say what they do? [Poster] *Proceedings 2nd Science Learning and Teaching Conference*. Keele University: Keele, UK 19-20 June 2007.

Invited articles, presentations & External Workshops

1. Moss, K., 2009. Threshold Concepts, Troublesome Knowledge and Effective Learning in Science [Invited lecture] *Swedish Chemical Society Annual Chemistry Teachers Conference*. Sigtuna, Sweden 22-23 March 2009.
2. Moss, K. Crowley, M., 2009. Communicating Science - CELS style! [Invited workshop] *Norwegian Science Week Planning Conference*, Norwegian Research Council, Oxford, UK 12 March.
3. Forsythe, S., 2009. Teaching the 'BIO' in Microbial BIOinformatics, *UK Centre For Bioscience Bulletin*, Summer 2009, pp6.
4. Manning, G. Moss, K., 2009. Getting the bug in schools. *Microbiology Today*, May 2009, pp110-112.
5. Manning, G. Moss, K., 2009. Practical Skills in Biology– Engaging Your Future Market, *Centre for Bioscience Bulletin*, Spring 2009, pp8.
6. Moss, K., 2008. What is impact and what does it mean for your CETL? [Invited workshop] *CETL development event*, Middlesex University: Middlesex, UK. 26 June 2008.
7. Moss, K. Greenall, C, Rockcliffe, A. Crowley, M. Mealing, A. Saleem, S., 2008. Threshold Concepts and Troublesome Knowledge in Chemistry. [Invited Paper] *School of Science & Technology Research Conference*. Nottingham Trent University: Nottingham, UK ` 13-14 May 2008.
8. Moss, K., 2008. Impact - how do we measure it? [Invited workshop] *Annual CETL conference*. University of Leicester: Leicester, UK 17-18 April 2008.
9. ICARUS theatre productions 2006, 2007 [RUMNEY, P. and SCRIVEN, N., 2007, Crossing boundaries: the Icarus project. DVD. Andrew Robinson for NTU / Dragon Breath ; RUMNEY, P. and SCRIVEN, N., 2007, The Icarus Project: theatre design course. DVD. Creative Partnerships/Dragon Breath] COSMOS theatre productions 2008, 2009
10. Moss, K., 2006. Separation or Collaboration? [Paper] *Outreach in Collaboration Conference*. Nottingham Trent University: Nottingham, UK 18 October 2006.
11. Moss, K., 2006. Context-Based Learning – what's in it for me? [Invited Plenary lecture/workshop] *Irish Variety in Chemistry Education Conference*. Dublin, Ireland 10-11 April 2006.

Articles submitted

Kuksa, I. Scriven, N. Rumney, P., 2010. The Cosmos Project: a Journey to the Stars, *Research into Drama Education*

Moss, K. Crowley, M., 2010. Using personal response systems for effective learning in science, *Computers & Education*

Brown, C. Crowley, M, Newton, M. Parker, D. Pollard, H. Forensic Physics (Ballistics): A school science outreach and engagement event, *Physics Education*

Brown, C. V. Herrick, C. D. Newton, M. I. Parker, D. A. A straightforward undergraduate laboratory experiment to measure the drag coefficient for a sphere. *European Journal of Physics*

Annex B: CELS TIPS-TOPS Sabbatical Projects 2005-2010

| Authors | Lead Subject Area | Project Title |
|---|--------------------------|--|
| Billett, Ellen | Biosciences | Flexible learning MSc module: Cell culture and antibody technology |
| Birkett, Jason | Forensics | Developing an Inquiry-Based Learning package in forensic science |
| Bonner, Phil | Biosciences | Interactive e-learning System for Teaching Protein Purification Techniques |
| Brown, Carl | Physics & Forensics | Outreach in ballistics & display technology |
| Bussell, Chris | Sport | Live projects in sport |
| Bussell, Chris; Elliott-Sale, Kirsty; Compton, Graham | Sport | Use of multi-media to support the student learning experience in standard operating procedures for laboratory work: "hand held tutors" |
| Cave, Gareth | Chemistry | Promoting and Developing Green Chemistry |
| Compton, Graham | Sport | Use of automated assignment marking systems in grading essays |
| Cox, Helen | Animal Studies (ARES) | Developing and Delivering Outreach Activity Days between schools and ARES FE/HE programmes |
| | | |
| Evett, Lindsay | Computing | Creating an accessible learning and teaching environment in SST |
| Fairhurst, David | Physics | Hands on science exhibits |
| Forsythe, Stephen | Biosciences | Genomic and post-genomic investigation of micro-organisms |
| | | |
| Halfpenny, Joan | Chemistry & Forensics | Forensic Skills Development in Criminalistics Practical Work |
| Hanley, Quentin | Chemistry | Chemistry & Forensics team- Team project in Retention, Recruitment and Feedback |
| Hargreaves, Alan | Biosciences | Development of Research Methods and IT (e-learning Masters module) |
| Hartley, Joanna; Smith, Pauline; Allen, Tony | Computing | Enhancing the Student Experience: Final Degree Portfolios and Motivational Events for All Levels |
| Hartley, Joanne | Computing | Computing and Technology Student Ambassador Scheme |
| Kirk, Sandra | Biosciences | Development of Special Topics in Molecular Biology (e-learning Masters module) |
| Langensiepen, Caroline | Computing | A new approach to teaching Programming |
| Manning, Gina | Biosciences | To develop a bioscience portfolio of outreach events |

| Authors | Lead Subject Area | Project Title |
|--|--------------------------|---|
| McNally, Alan; Lloyd-Mills, Chris & Cheetham, Phil | Biosciences | Implementing a practical portfolio for Bioscience students: A step towards vocational training education |
| Mireylees, Stewart | Biosciences | Development of learning materials to support the acquisition of key practical skills in biological sciences |
| Neal, Bill | Physics | Fast-track package for FdSc Physics |
| Newton, Mike | Physics | Physics outreach activities |
| Sharpe, Graham | Sport | Formative Assessment of Large Groups |
| Sivasubramaniam, Shiva Das | Biosciences | Preparing school students to avoid plagiarism: anti-plagiarism activities to enhance their learning at university |
| Verderio Edwards, Elisabetta | Biosciences | Assessment of distance e-learning: The two sides of the coin |
| Wallis, John | Chemistry | Redesign of organic chemistry laboratories |

Annex C: Brief Descriptions of Kit in Kase Activities

Animal Detectives Activity (year 1 and 2)

Pupils are introduced to some of the ideas behind forensic science and then take part in a series of activities to help solve a 'crime'

Animal Habitats (year 1 and 2)

This session introduces pupils to many different types of environment and explores why these are inhabited by certain types of creature

Materials (year 1 and 2)

This interactive presentation will explain to pupils about the classification of materials and their properties, which will determine their uses.

Animal and Adaptations (year 3 and 4)

Pupils 'become' an animal and think about their adaptations, habitat and their place in food chains. Pupils will also look at some insects in detail in order to identify their body parts and adaptations, appropriate for the Key Stage level.

The Body (year 3 and 4)

Pupils look at the skeleton and work towards building the body including the muscles and major organs.

Forensic Science (year 3-6)

The interactive session sets the scene of the crime and introduces the suspects. It also outlines each technique used to gather the evidence.

Bricks, Bananas and You: DNA Unravelling (year 5 and 6)

This interactive session introduces pupils to the building blocks of life. They look at the information and codes that are stored in nature and how these make you the person you are.

Oil-Spill Activity (year 5 and 6)

In groups, the pupils make their own 'sea' and then create a safe 'crude oil'. Using a range of household materials, they try to clean up the spill and compare the materials.

Colourful Chemistry (year 6)

The pupils work in pairs to investigate surface tension through the interaction of detergent with fats. The practical experiment involves the addition of various food dyes to milk, followed by the addition of liquid detergent and the results are observed.

Forensic Science (year 7-9)

Students will explore a crime investigation. They will be presented with evidence and background information that will allow them to eliminate suspects one by one.

Light-Up Materials (year 7-9)

This hands-on activity on "light up materials" is aimed at developing ideas about materials, display technology and engineering.

Pills, Jabs and Patches (year 7-9)

This hands-on activity allows pupils to explore the different methods of drug delivery and increase their awareness of drug development and industry.

Annex D: Website Resources for Schools www.ntu.ac.uk/cels

Primary resources

Fizzy rocket activity - This activity will give children the chance to design, build, test and redesign their own model rockets. This resource is suitable for pupils in Key Stages 1 and 2.

Gravity ball - Investigate the strength of gravity on the surface of different planets by throwing a virtual football. Can you work out which planet has the strongest gravitational pull? This resource is suitable for pupils in Key Stage 2.

Body parts - Do you know where in your body your heart, stomach or liver is? Learn more about these and other organs with this drag and drop activity. This resource is suitable for pupils in Key Stage 2.

Solar system - Find out where each of the planets in our solar system are positioned and the relative speeds at which they move around the sun. Solar system is designed for use on a whiteboard and is suitable for pupils in Key Stage 2.

Word loop - This resource will enable teachers to create quick and easy plenary and starter sessions that are fun for all levels.

Bingo cards - Another tool for the creation of quick and easy to use plenary and starter sessions. Science bingo is suitable for all levels and can also be adapted for any subject or topic.

Primary games and puzzles

Word search - Have a go at a science word search. Topics include materials, nature and temperature.

True or false quiz - Test your knowledge and discover weird and wonderful things you never knew about science. This is a fun quiz for all age groups.

Secondary resources

Atomic structure - Suitable for key stage 4/GCSE level. The interactive animations and complementary worksheet provide an introduction to atomic structure and ionic, covalent and metallic bonding.

Quantitative chemistry - Suitable for Key Stage 4/GCSE level. This worksheet covers chemical formulae, word and symbol equations, equation balancing and chemical masses and volumes.

Animated atomic clock - This resource is suitable students in Key Stages 3 and 4. The atomic clock can be used as part of a fun activity to introduce students to atomic numbers. For example, what time is HSn, HBr, NaP, LiZr or Cn?

From DNA to a protein - Suitable for "gifted and talented" Key Stage 4 students. This worksheet looks at the roles of DNA and mRNA in the manufacture of the body's proteins.

Line of best fit - This interactive Flash animation has been created as a tool to help discuss and display lines of best fit. This resource is suitable for students in Key Stage 4.

Gradient - This interactive Flash animation has been created as a tool to help show and discuss the measuring of gradients. This resource is suitable for students in Key Stage 4.

Secondary games and puzzles

Periodic Table sudokus - Put your puzzle solving skills to the test. These sudokus use the first 9 elements of the Periodic Table.

Close-up-match-up - These close up images of everyday objects are taken using a very powerful microscope, - can you guess what they are?

Post-16 resources

Mole and dilution factor calculators - These interactive animations can be used to help explain the calculation of moles. They also demonstrate the relationships between RMM, mass and moles, and concentration, volume and moles.

Spectroscopy - An animated presentation to illustrate spectroscopic techniques such as NMR, IR and Mass Spectrometry.

From DNA to a protein - Suitable for students studying at post-Key Stage 4. This worksheet covers the roles of DNA and mRNA in the manufacture of the body's proteins.

Post-16 games and puzzles

Close-up-match-up - These close up images of everyday objects are taken using a very powerful microscope, can you guess what they are?

Annex E: TIPS-TOPS Outputs

(i.e. up to 2009 only, other projects still in progress)

| | |
|-----------------------|--|
| Ellen Billett | <p>Flexible learning MSc module: Cell culture and antibody technology</p> <p>Distance e-learning module for MSc Biomedical Sciences Flexible Learning Programme. Information on assessment of issues arising during Live Meeting sessions.</p> |
| Jason Birkett | <p>Developing an Inquiry-Based Learning package in Forensic Science</p> <p>Problem-based learning package for Forensic Science teaching at undergraduate level.</p> |
| Phil Bonner | <p>Interactive e-learning System for Teaching Protein Purification Techniques</p> <p>Interactive resource and information platform to support use of interactive IT programme ('Protein Lab') – accessed through NTU 'NOW' VLE.</p> |
| Carl Brown | <p>Outreach in ballistics & display technology</p> <p>Laboratory scripts and data analysis information for a series of Ballistics Outreach activities.</p> |
| Chris Bussell | <p>Live projects in sport</p> <p>Questionnaires for key stakeholders (students, staff, businesses). notes and commentary on the use of live projects.</p> |
| Gareth Cave | <p>Promoting and Developing Green Chemistry</p> <p>Lecture notes, laboratory practicals, talks given for Outreach activities.</p> |
| Graham Compton | <p>Use of automated assignment marking systems in grading essays</p> <p>Evaluation of 'BETSY' system for automated assignment marking.</p> |
| Helen Cox | <p>Developing and Delivering Outreach Activity Days between schools and ARES FE/HE programmes</p> <p>Materials pack for Master Classes, including information for participants, protocols for laboratory work, animal track information.</p> |
| Mark Crowley | <p>Teaching Research Fellow</p> <p>Experiments at School website, dynamic data handling tool, drag and drop resource tool, laboratory scripts for outreach events (20+), PowerPoint presentations for outreach events (50+), all documentation and VLE content for UAS, CD of</p> |

exemplar CELS material and SIG Animations and Simulations training CD, teaching content for ITT and ASE workshops including novel use of nappies and toys for CBL.

Lindsay Evett

Creating an accessible learning and teaching environment in SST

Set of guidelines contributing to NTU recommendations on accessible learning and teaching on the VLE.

David Fairhurst

Hands on science exhibits

Wind Turbine and Electromagnetic Induction demonstration models.

Stephen Forsythe

Genomic and post-genomic investigation of micro-organisms

HTML- based teaching material on 'Genomic and post-genomic investigation of micro-organisms'.

Joan Halfpenny

Forensic Skills Development in Criminalistics Practical Work

10 exercises/analytical techniques, with associated proformas, for the teaching of Forensic Science plus lecture content

Alan Hargreaves

Development of Research Methods and IT (e-learning Masters module)

Flexible learning e-learning module for Research Methods and IT.

Jo Hartley

Computing and Technology Student Ambassador Scheme

Mentor Scheme material (Programme Specification, Induction Timetable, Certificate, student feedback).

Sandra Kirk

Development of Special Topics in Molecular Biology (e-learning Masters module)

Material for the delivery of the MSc Biomedical Sciences Flexible Learning programme, including web pages, MCQs, interactive facility.

Caroline Langensiepen

A new approach to teaching Programming

Written computer programming instructions including code, instructions, drop box and primer.

Gina Manning

To develop a bioscience portfolio of outreach events

Portfolio of 22 Bioscience seminars/taster sessions for schools and colleges within the region.

Stewart Mireylees

Development of learning materials to support the acquisition of key practical skills in biological sciences

DVD on 'Use of mechanical pipettes'.

| | |
|------------------------------------|--|
| Mike Newton | Physics outreach activities Laboratory manual, including use of laptop computer with motion analysis software. |
| Graham Sharpe | Formative Assessment of Large Groups Mark sheets and exemplar material for student use. |
| Elisabetta Verderio-Edwards | Assessment of distance e-learning: The two sides of the coin Student and staff survey questionnaires, literature review, 'Elementary e-learning Seminar', in respect of distance e-learning MSc. |
| John Wallis | Redesign of organic chemistry laboratories Practical Organic Chemistry laboratory manual and Physical Organic Chemistry lectures. |

Annex F: List of School Activities

| | |
|---|------------|
| Activity Days- Primary | 26 |
| Activity days – Secondary- forensic, snap | 17 |
| Amazing magical science show | 15 |
| Animal Extravaganza | 2 |
| Animals and Plants Day | 1 |
| Archaeo-Astronomy Summer School | 1 |
| Astronomy events | 7 |
| Bespoke Workshops | 6 |
| Careers event | 8 |
| C:TNG events | 21 |
| Work with other centres CALMAST /GENIE | 3 |
| Careers Day | 6 |
| Dragsters Bronze CREST award | 2 |
| European Festival events | 4 |
| Exploding Science | 2 |
| Float Your Boat Activity Day | 3 |
| Forces and Flames | 6 |
| Forensics Activity Day | 7 |
| Forensics CPD for teachers | 1 |
| Gene Therapy Seminar | 1 |
| Go4SET | 3 |
| Headstart – CREST Bronze | 3 |
| Healthy Eating & the Body Activity Day | 2 |
| IOB Poster Competition | 1 |
| Kit in a Kase | 304 |
| Korean Science Camp | 2 |
| Lab in a Lorry | 1 |
| Lectures – FS/Nano/Fuels/Choc/Fireworks/demo/MRI/ Vampire Bacteria/Medicine/ Fine Art/Flesh eating/ | 23 |
| Maggots, Murder & Mystery | 1 |
| Master Classes – astronomy(9)CIT(1)DNA(6)FMicro(3)Micro(3)Para(1)Rate(8)Phy(2) PigFlu(1)Sport(3) Synth(70)Bird(2) | |
| Minibeasts workshop | 2 |
| Public Engagement Nano-roadshow, Market Square, Nottingham | 4 |
| Nappy Power workshop | 5 |
| Physics of Forensics Competition | 5 |
| RSC Schools Analyst Competition | 5 |
| Salters Chemistry Festival | 5 |
| Science Enterprise Day | 1 |
| Science Evening | 7 |
| Science is Fun | 1 |
| Scouts/Brownies Science/Stagazer | 2 |
| Skateboard Ronnie – Physics workshop | 1 |
| Slime Workshop | 6 |
| Work experience students | 17 |
| WP/AH Summer schools & university days | 10 |
| Young Engineers for Britain/K'NEX challenge | 4 |
| Total School Activities | 654 |

Annex G: Partnership Events

CELS have run numerous events through which we have collaborated with other STEM (Science Technology Engineering and Maths) providers in the East Midlands and further afield. These collaborative approaches allow CELS to provide sessions in their own style but potentially reach a wider audience across the region. Regardless of the collaborative partners for an event and the time frame given for an event CELS activities and sessions follow the same methodology and model. CELS activities are designed to allow the pupils to explore and investigate a topic through hands-on minds-on science.

| Event | Partner |
|--|--------------------------|
| Amazing Magical Science Show | Dr Mark |
| Boys into Healthcare | Aim Higher Nottingham |
| C:TNG Careers event | RSC |
| C:TNG Spring School | RSC |
| C:TNG Spring School Workshop | RSC |
| Careers evening | Aim Higher Nottingham |
| CREST Awards | EDT |
| Fuel cell workshop for 'Fuelling the Future' | IOP |
| Go 4 SET celebration event | EDT |
| Go 4 SET Launch event | EDT |
| Hands on and Hands Free C:TNG event | RSC |
| Headstart – CREST Bronze Dragster racing | EDT |
| Headstart - Dragster Day | EDT |
| K'NEX Challenge | EDT |
| Know Chemistry | RSC |
| Korean Science Camp | LG |
| Lab in a Lorry | IOP |
| Nano-roadshow, Market Square, Nottingham | Aim Higer Nottingham |
| RSC Young Analyst Chemistry Competition | RSC |
| Sci Tec | Salters |
| Snap Crackle and Snot | Sci Tec |
| The Salters Festival of Chemistry | University of Nottingham |
| What Next? 2009 careers and HE fair | Salters |
| Wonders Project: Colour Changing Materials | Aim Higer Nottingham |
| Wonders Science Festival, Perugia, Italy | EUSCEA |
| Young Engineers for Britain | RSC |
| Young Engineers K'NEX challenge | EDT |

EDT= Engineering Development Trust

Annex H: Dissemination Events for last 3 years

2009

- Interactive Technologies and Games: Education, Health and Disability conference, Nottingham
 - *Using personal response systems for effective learning.* [presentation]
- What Next? Careers event, Harvey Hadden Stadium, Nottingham
 - With interactive activities
- Science Learning and Teaching Conference, Nottingham Trent University, Nottingham
 - *Using student ambassadors to aid retention of first year students.* [presentation]
- Nottingham Midsummer Energy Festival, Green's Windmill, Nottingham
 - With interactive activities
- The Science Learning and Teaching Conference, Heriot-Watt University, Edinburgh
 - *Developments across the curriculum: problem-based and context-based learning resources within the chemical curriculum at NTU.* [presentation]
 - *Using Student Ambassadors to aid retention of first year students.* [presentation]
 - *Assessing student e-learning in microbial bioinformatics.* [poster]
 - *Real data for real learning - a live dynamic tool to aid teaching and learning.* [poster]
 - *Science targeted recruitment: not just for post-16 students.* [poster]
- Enterprise in Science Education, CELS, Nottingham Trent University
 - With presentation by Dr Catherine Sanderson
- Perugian Science Festival, Perugia, Italy
 - With poster presentations and interactive activities
- Visit to Sigtuna, Sweden
 - With presentation to Swedish teachers about the work of CELS
- National Science and Engineering Week, Oxford
 - With presentation to the National Norwegian Science Week Secretariat.

2008

- Schools and Higher Education, putting policy into practice, University of Nottingham, Nottingham
 - With round table discussion about STEM outreach activities
- Outreach in Collaboration II, CELS, Nottingham Trent University
 - *'Kit in a Kase' - Outreach activities for all.* [workshop]
 - *CELS - Outreach in partnership* [presentation]
- Physics in Higher Education Conference 2008, University of Edinburgh
 - *Student attitudes to physics at school and university.* [presentation]
- Variety in Chemistry Education Conference, Dublin City University
 - *The shape of chemistry in 2008.* [presentation]
- FP7 - Science in Society meeting, Brussels
 - Meeting with European partners to discuss funding proposal
- Higher Education Academy Conference, Harrogate
 - *Vehicles for change: developmental schemes, their impact and implications.* [presentation]
- Aimhigher School Teachers' event, Nottingham Trent University
 - *The work of CELS.* [presentation]
- TIPS TOPS Conference, Nottingham Trent University
 - Sabbatical projects at CELS [presentation] [poster]
- Stimulating Physics: Improving access, creating demand, London
 - With presentation
- The London SoTL 7th International Conference, London
 - *Boundaries as borders, or margins? Policy, SoTL and developmental schemes.* [paper]
- School of Science and Technology research Conference 2008, Nottingham Trent University
 - *Threshold concepts and troublesome knowledge in chemistry* [presentation]
- WONDERS European Science Festival, Prague

- *Challenging perceptions of science.* [presentation]
- 10th Annual learning and Teaching Conference, Nottingham Trent University
 - *The Computing and Technology Student Ambassador Scheme.* [presentation]
 - With posters and publicity material
- Animations and Simulations Special Interest Group (SIG), CELS, Nottingham Trent University
 - *Animations with and within PowerPoint* [workshop]
- Nottinghamshire Science Subject Leaders' Conference 2008
 - With demonstrations, workshops, presentations and hands-on activities

2007

- Art and Design School Day, Nottingham Trent University, Nottingham
 - *The work of CELS and e-learning projects.* [presentation]
- Wonders Science Festival, Lisbon, Portugal
 - Exhibition with interactive activities and promotional materials
- Heads of Chemistry UK meeting, Royal Society of Chemistry, London
 - *The work of CELS* [presentation]
- RSC Educational Techniques Group Trust meeting, Nottingham
- East Midlands STEM support partnership, National Space Centre, Leicester
 - With presentation, posters and publicity material
- National Science Week in Norway 2007
 - With interactive activities
- Academic Standards and Quality Committee, Nottingham Trent University
 - *Interim CETL self-evaluation report* [presentation]
- NTU working together: a staff celebration
 - With hands-on exhibits, posters and publicity material
- Quarrydale Science School Launch
 - With presentation

Press coverage

| Date | Title of report | Publication |
|------------|--|--|
| 29/05/2006 | School's winning streak of prizes | Evening Telegraph (Peterborough) |
| 29/06/2006 | Picture this! Twin celebrations for golden jubilee school | Lincolnshire Echo Scunthorpe Evening Telegraph |
| 29/07/2006 | Budding scientists encouraged to enter challenges | RDA News (Regional Development Agencies) |
| 01/04/2006 | Salters Festival of Chemistry, NTU | Nottingham Evening Post |
| 24/05/2006 | Design skills put to the test | Newark Advertiser |
| 26/05/2006 | Science fun | Newark advertiser |
| 19/05/2006 | Model ideas to the test | Nottingham Evening Post |
| 08/06/2006 | Chemistry Week: Nottingham Trent University | Nottingham Evening Post |
| 14/11/2006 | Science play | Nottingham Evening Post |
| 07/03/2007 | Pupils' work in class will be rocket science | Nottingham Evening Post |
| 09/03/2007 | | BBC News - East Midlands Today (6pm news) |
| 30/03/2007 | CELS opening by Adam Hart-Davis | BBC Radio Nottingham |
| 30/03/2007 | CELS opening by Adam Hart-Davis | Nottingham Evening Post |
| 05/04/2007 | More science please | EMUA newsletter |
| 07/04/2007 | The East Midlands CETL Network | Nottingham Evening Post |
| 07/04/2007 | Boon for science | Nottingham Evening Post |
| 10/04/2007 | Chemistry students' taster | Nottingham Evening Post |
| 27/04/2007 | Who got that cash? | The Times Higher |
| April 2007 | Science with a conscience Bright sparks put chemistry knowledge to the test | Nottingham Evening Post Nottingham Evening Post |
| 17/05/2007 | | Nottingham Evening Post |

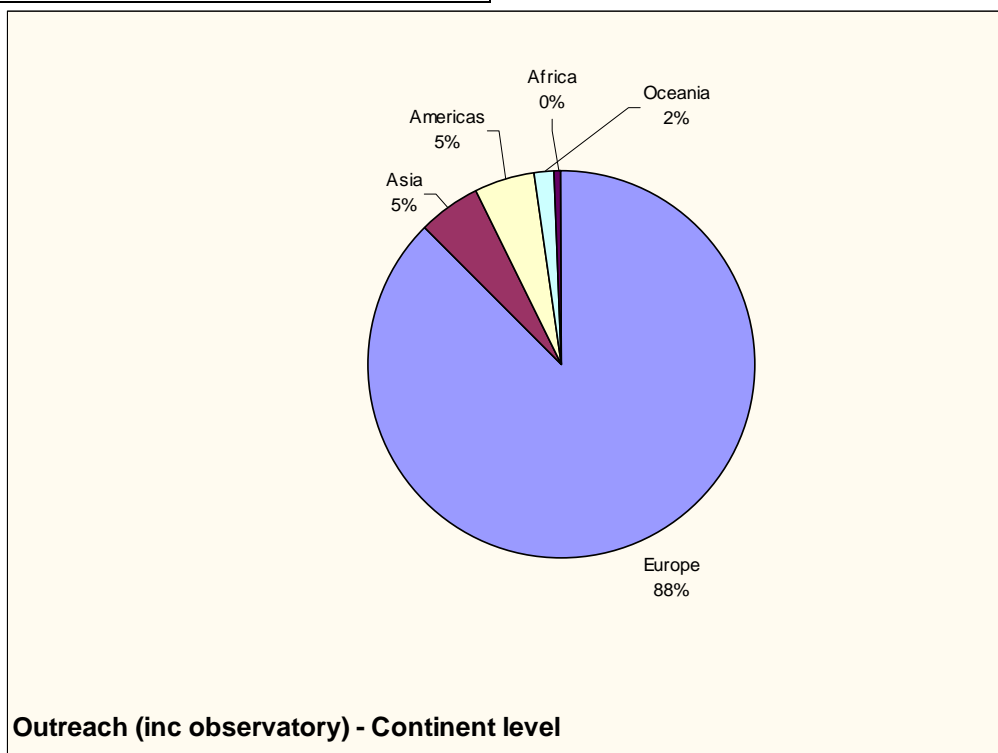
| | | |
|-------------|--|--|
| | A cosmic launch for CELS | Grapevine Vol 23 Issue 5 |
| | Celebration for young scientists | Grapevine Vol 23 Issue 5 |
| | Mythology makes a moral message | Grapevine Vol 23 Issue 5 |
| Spring 07 | Nurturing science | Network Spring 07 |
| Jun-07 | Big fun at the County show | Grapevine Vol 23 Issue 6 |
| Jun-07 | Nano comes to Nottingham | Grapevine Vol 23 Issue 6 |
| Spring 07 | Chemistry Week @ CELS | School News Spring 07 |
| | The East Midlands Network of Centres for Excellence in Teaching and learning | Regional Monitor |
| 01/06/2007 | Scaring good practice in graduate recruitment | Derby Evening Telegraph |
| 18/07/2007 | CELS welcomes MP | Grapevine Vol 23 Issue 7 |
| Aug-07 | Perfect practice | Grapevine Vol 23 Issue 7 |
| Aug-07 | Effervescence for adolescents | Grapevine Vol 23 Issue 7 |
| | The Times Higher Awards 2007 | The Times Higher (supplement for short listed candidates) |
| 28/09/2007 | Liquid rainbows: British colour researchers meet Norwegian children | EurekaAlert! |
| 28/09/2007 | Norway - Science Week | Norwegian TV |
| Nov 2007 | A showcase for teamwork at NTU | Grapevine Vol 24 Issue 2 |
| Nov 2007 | NTU in running for national prizes | Grapevine Vol 24 Issue 2 |
| | Dragon breath theatre presents | NTU production (CD format) |
| Nov 2007 | Crossing Boundaries | Grapevine Vol 24 Issue 3 |
| Dec-07 | Fuelling the Future | RSC News |
| Dec-07 | Chemistry Week-Round-up | Rutland mercury |
| Mar-08 | Lab in a Lorry heads for Burghley | NTU annual report 2007 |
| – | NTU at the heart of the community | Lichfield Mercury |
| 20/03/2008 | It's CSI: Lichfield | Nottingham Evening Post |
| 02/04/2008 | Chemistry kids make the final | Nottingham Evening Post |
| 02/04/2008 | Kids try sweet and sour | Nottingham Evening Post |
| | Testing times for pupils in Midlands chemistry final | Nottingham Evening Post |
| 09/04/2008 | Small wonders...Nano show hits the City | Nottingham Evening Post |
| 12/04/2008 | | Nottingham Evening Post |
| Apr 2008 | Floating rainbows - exploding milk | Wonders European Science Festival - Final report |
| 27/03/2008 | They went for it at Go4SET | Lutterworth Mail |
| May 08 | Pouring enthusiasm into science | Grapevine Vol 24 issue 6 |
| May 08 | Sky gazers explore heavens above | Grapevine Vol 24 issue 6 |
| | NTU supports East Midlands Nanotechnology Road show | inloughborough.com |
| 01/05/2008 | Pupils worth their salters' | Nottingham Evening Post |
| 26/05/2008 | Radio interview with Dan Brown and Haida Liang | BBC radio Nottingham |
| 17/06/2008 | Korean TV appearance | Science TV |
| 19/07/2008 | Solar eclipse in city | Nottingham Evening Post |
| 31/07/2008 | Solar eclipse | BBC radio Nottingham |
| 01/08/2008 | Solar eclipse | BBC radio Nottingham |
| 06/08/2008 | Snap Crackle and Snot | RSS News |
| ??/11/2008 | Statistics open day | Arrow - the science issue (Nottingham City Council) (posted every household in city) |
| ??/11/2008 | A year for learning | Nottingham Evening Post |
| 22/11/2008 | Take a closer look at Saturn | Insciences Organisation |
| 27/11/2008 | The view from Saturn | Nottingham Recorder |
| 27/11/2008 | Saturn treat | Reactions (Chemistry for our future) |
| Spring 2009 | A life without chemists? | Chemistry World (April 2009) |
| | The changing shape of chemistry, 1998 to 2008 | |
| Apr 2009 | | |

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|------------|---|---|
| 02/04/2009 | Moon watch event | http://www.thisisnottingham.co.uk/news/Moon-watch-Clifton/article-866308-detail/article.html |
| 23/04/2009 | Meet the world's top astronomers | http://news.bbc.co.uk/cbbcnews/hi/newsid_801000/newsid_8014100/8014158.stm |
| 23/04/2009 | Mini brainiacs at European Week of Astronomy meeting | http://www.youtube.com/watch?v=sz3wxEPRXsE&feature=player_embedded |
| 24/04/2009 | Reports from the European Week of Astronomy and Space Science | http://www.astronomynow.com/nam09/ |
| 27/05/2009 | Star gazers welcomed at university | http://www.thisisnottingham.co.uk/news/Star-gazers-welcomed-university/article-1027964-detail/article.html |
| May 09 | Getting the bug in schools | http://www.sgm.ac.uk/pubs/micro_today/pdf/050909.pdf |
| | Teaching the 'BIO' in microbial | |
| Summer 09 | BIOinformatics | Centre for Biosciences bulletin |
| | The IYA2009 in Europe at JENAM | Communicating Astronomy with the |
| June 09 | 2009 | Public (CAP) Journal |
| | Primary pupils give summer school a | |
| Summer 09 | High 5 | Aimhigher Nottinghamshire newsletter |

Annex I: Web Access by Country

Over 73 countries have accessed the site

| Outreach Resources | |
|---------------------------|-----------|
| Continent | Pageviews |
| Europe | 42523 |
| Asia | 2495 |
| Americas | 2479 |
| Oceania | 819 |
| Africa | 211 |



| Molecular Geometry pages | |
|---------------------------------|-----------|
| Continent | Pageviews |
| Europe | 7320 |
| Americas | 7129 |
| Asia | 4642 |
| Oceania | 438 |
| Africa | 260 |
| Top 25 countries | |
| By Country | Pageviews |
| United States | 5705 |
| United Kingdom | 3777 |
| India | 1135 |
| Canada | 1035 |
| Belgium | 517 |
| Singapore | 419 |
| Philippines | 395 |
| Hong Kong | 277 |
| Thailand | 276 |
| Pakistan | 269 |
| Germany | 264 |
| Spain | 262 |
| Czech Republic | 242 |

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|--------------|-----|
| Malaysia | 237 |
| Poland | 204 |
| Sri Lanka | 187 |
| France | 156 |
| South Korea | 152 |
| Ireland | 143 |
| Saudi Arabia | 134 |
| Egypt | 120 |
| Italy | 114 |
| Brazil | 103 |
| Netherlands | 101 |

