

HEFCE CETL Final Evaluation Report

March 2010

**sigma
Centre for Excellence
in the Provision of University-wide
Mathematics & Statistics Support**

**Mathematics Education Centre, Loughborough University
and
Mathematics Support Centre, Coventry University**

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Part One: Statistical Information

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| Name of CETL | sigma – Centre for Excellence in the university-wide provision of mathematics and statistics support |
| Name of institutions | Loughborough and Coventry Universities |
| Contact name | Professor Tony Croft, Loughborough University |
| Name of person submitting the self-evaluation | Moira Petrie, Assistant Director, sigma CETL, Loughborough University |
| Start date of CETL | 1 August 2005 |
| Anticipated end date | <p>31 July 2010 (end of HEFCE CETL funding)</p> <p>After this date, university funding has been secured for the continued provision of the services provided by sigma through the Mathematics Education Centre at Loughborough and the Mathematics Support Centre at Coventry.</p> <p>At Loughborough, funding of £250,000 per year has been secured. At Coventry, funding of £150,000 per year has been secured.</p> <p>In recognition of its work transferring good practice to other HEIs, the National HE-STEM Programme has asked sigma to be one of its delivery partners. Funding of £295,000 has been allocated to sigma to continue to deliver some of its outreach work with other universities, using models it has already implemented. sigma's outputs underlined the importance of including mathematics support in the national STEM agenda.</p> |
| Lead directors | Professor Tony Croft, Loughborough University Professor Duncan Lawson, Coventry University |
| Total amount of award | <p>£4.85 million, broken down as follows:</p> <p>£2.5 million recurrent funding £2.35 million capital funding</p> |
| Capital Spend | <p>The capital spend was used in the four key ways – the development of mathematics support drop-in facilities, interactive classrooms, provision of staff space and purchasing of equipment:</p> <p>@Loughborough (LU)</p> <ul style="list-style-type: none"> the existing Mathematics Learning Support Centre was refurbished, with a new "overspill" area to accommodate an extra 25 students. An additional centre in a different campus location has also been created, accommodating up to 40 students. The Eureka Centre for Mathematical Confidence was established. It is a safe space, separate from the drop-in centres, where students anxious about mathematics can build their confidence in number work gradually without judgement. The Eureka Centre can accommodate up to 12 students. A resource room has been established for Second and Third Year Mathematical Sciences students. This room accommodates up to 20 students. Two interactive classrooms - one with 29 seats and a second with 60 seats that can be partitioned into separate classrooms with 28 and 32 seats – were created and fully equipped. |

| | <ul style="list-style-type: none"> The entire Mathematics Education Centre (which houses sigma at LU) was relocated to newly refurbished office space on the centre of campus, near to the new drop-in centre. This includes 11 individual staff offices, 4 shared staff offices (including an open plan office seating up to 9 staff), a kitchen and 2 seminar rooms. <p>@Coventry (CU)</p> <ul style="list-style-type: none"> The Mathematics Support Centre was re-located to a larger refurbished space. The new drop-in centre now has seating for 42 students at study desks and provides 9 computer stations for student use. An interactive classroom was created, with seven circular-shaped computer areas, giving a 42 capacity classroom. A second interactive classroom was also created with seating for 25 students. The function of this room was changed to provide a study and resource room for Second and Third Year Mathematical Sciences students. An open plan office space for 4 staff has been created adjacent to the drop-in centre. An additional 4 individual offices for sigma staff were refurbished. A seminar room, which can hold up to 20 people in a boardroom style setting, was acquired and refurbished. The seminar room also has a small kitchen and a comfortable seating area, for staff to meet in a more informal environment. A video recording studio has been opened with filming equipment and a full editing suite. <p>Capital funding has also enabled sigma to purchase a wide range of equipment to improve the learning experience of students and the working experience of staff, including:</p> <ul style="list-style-type: none"> A range of educational technologies (interactive whiteboard technology, voting systems, etc.) has been purchased so that sigma can evaluate their use in different settings and then pass the lessons learnt on to the wider HE community. A number of off-the-shelf hardware products have been purchased to provide variety in the way in which mathematics support can be delivered. These include Tablet Laptops, PDAs, iPods, robotic LEGO®, ultra-mobile PCs and Nintendo DS Lites. A sophisticated Video Conferencing system has been installed to enable more frequent face-to-face communication between LU and CU, and also the MSOR Network. New computing equipment has been purchased for all staff. | | | | | | | | | | | | |
|--|--|----------|-----|----------|---------|------------|---------|-------|---------|-------------------|---------|------------|---------|
| <p>Use of facilities in 2010/2011</p> | <p>At both institutions, the drop-in centre facilities will continue to be used, funded from central university funding. The Eureka Centre will be maintained. The refurbished staff offices, seminar rooms and other dedicated rooms at both institutions will be maintained and used in furtherance of mathematics education and support work</p> | | | | | | | | | | | | |
| <p>CETL staff</p> | <table border="1"> <thead> <tr> <th>Job Type</th> <th>FTE</th> </tr> </thead> <tbody> <tr> <td>Academic</td> <td>5.8 FTE</td> </tr> <tr> <td>Managerial</td> <td>1.0 FTE</td> </tr> <tr> <td>Admin</td> <td>1.7 FTE</td> </tr> <tr> <td>Technical Support</td> <td>2.0 FTE</td> </tr> <tr> <td>Evaluation</td> <td>0.1 FTE</td> </tr> </tbody> </table> | Job Type | FTE | Academic | 5.8 FTE | Managerial | 1.0 FTE | Admin | 1.7 FTE | Technical Support | 2.0 FTE | Evaluation | 0.1 FTE |
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| Admin | 1.7 FTE | | | | | | | | | | | | |
| Technical Support | 2.0 FTE | | | | | | | | | | | | |
| Evaluation | 0.1 FTE | | | | | | | | | | | | |

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|---|---|-----------------------|---|
| Future roles of CETL staff | Job Type | FTE | Future Roles |
| | Academic | 5.8 FTE | 1 senior research fellow (0.9 FTE) already secured 0.5FTE position at another HEI 2 directors (equivalent of 0.4 FTE) will return full time to university role 1 full time academic will be funded by individual institutions through continuation funding secured 1 FTE retired Other posts unclear at this time |
| | Managerial | 1.0 FTE | Unclear at this time |
| | Admin | 1.7 FTE | all part time admin staff will be funded by individual institutions through continuation funding secured |
| | Technical Support | 2.0 FTE | Unclear at this time |
| | Evaluation | 0.1 FTE | Unclear at this time |
| "Spin out" projects | Project Title | Amount Awarded | Institution |
| | Funded Centre | £20,000 | Leeds University |
| | Funded Centre | £15,000 | Sheffield University |
| | Funded Centre | £15,000 | Bath University |
| | sigma Hub Pilot | £5,000 | Bath University |
| | sigma Hub Pilot | £5,000 | St Andrews University |
| | Technology Evaluation Project – "To evaluate the use of graphic tablets and an interactive panel with First Year Human Biology students" | £5,000 | (HOST) LU |
| | Technology Evaluation Project – "To implement and evaluate the use of interactive workshop technologies to facilitate statistics teaching within the research module of the Doctorate in Clinical Psychology" | £5,000 | (HOST) CU |
| | Technology Evaluation Project – "Using the Matlab wavelet toolbox, to develop a web-accessible guided learning handbook, to provide a link between theoretical lectures and software help files" | £5,000 | (HOST) CU |
| | Technology Evaluation Project – "To evaluate acoustic related software with the aim of improving maths skills through the teaching of acoustics " | £5,000 | (HOST) CU |
| | Technology Evaluation Project – Bluetooth Higher Education Server Trial (BHEST) | £5,000 | (HOST) CU |
| Technology Evaluation Project – "to evaluate an interactive | £5,000 | (HOST) CU | |

| | | | |
|--|---|---------|---|
| | whiteboard and voting system in teaching Psychology and Nursing students" | | |
| | Mini project – "Adapting geogebra for tablet PCs" | £2,000 | Birmingham University and Queen Mary School |
| | Mini project – "Resources in mathematics for use with Electronic Voting Systems" | £2,000 | (HOST) LU |
| | Mini project – "The design of a computer-based maths toolbox for engineering students" | £1,750 | Imperial College (sigma contribution represented 50% of the overall funding, 50% was funded through the HEA Engineering Subject Centre) |
| | Secondment project – "Head Start Maths" | £3,000 | Limerick University |
| | Secondment project – "Study Skills leaflets for mathematics students" | £3,000 | The Open University |
| | Secondment project – "To develop new materials to aid the delivery and assessment of the quantitative methods segment of the Department of Politics, International Relations and European Studies Year 2 core module, Political Analysis" | £3,000 | (HOST) LU |
| | Secondment project – "Development of Maths Support for Scientists Pilot" | £3,000 | Aberdeen University |
| | Secondment project – "Trialling the DyscalculiUM screener in a Sixth Form College setting" | £3,000 | Sixth Form College Solihull |
| | Secondment project – "To use novel approaches to produce a sample refresher session on a common problem area in basic mathematics" | £500 | Dublin City University |
| | Secondment project – "Using humour and the history of maths to encourage students who are struggling" | £500 | NUI Maynooth |
| | Visiting Fellow Scheme – Dr Yvette Solomon (working with Prof Tony Croft and Prof Duncan Lawson on research projects relating to learner identities) | £12,000 | Manchester Metropolitan University |
| | Visiting Fellow Scheme – Dr Helen McGillivray (working with Dr Richard Gadsden on analysing diagnostic test results) | £4,000 | Queensland University of Technology (QUT) |
| | Visiting Fellow Scheme – Dr David Saunders (working with members of sigma on technical proofs of concept projects) | £6,000 | Sympletka Ltd |
| | Visiting Fellow – Dr Trevor | £4,000 | University of Warwick |

| | | | | | | | |
|---------------------------------------|---|--|--|-----------------------------|---------------------------------------|---------------------------------|--------------------------|
| | <p>Hawkes (working with Dr Lara Alcock on projects relating to second year specialist mathematics students and their career aspirations)</p> | | | | | | |
| <p>Peer reviews outputs</p> | <p>sigma has also played a significant role in securing the involvement of LU and CU in the following projects:</p> <table border="1"> <tr> <td>Further Mathematics Network</td> </tr> <tr> <td>Further Mathematics Support Programme</td> </tr> <tr> <td>Nuffield Science Bursary Scheme</td> </tr> <tr> <td>More Maths Grads Project</td> </tr> </table> <p>As at 31st December 2009:</p> <ul style="list-style-type: none"> 54 academic journal papers 3 books 5 book chapters 2 official reports 51 papers at international conferences 70 papers at national conferences 8 poster presentations 39 articles in professional newsletters <p>Full list available in Annex A. Outputs such as these are continuing to be delivered.</p> | | | Further Mathematics Network | Further Mathematics Support Programme | Nuffield Science Bursary Scheme | More Maths Grads Project |
| Further Mathematics Network | | | | | | | |
| Further Mathematics Support Programme | | | | | | | |
| Nuffield Science Bursary Scheme | | | | | | | |
| More Maths Grads Project | | | | | | | |
| <p>Dissemination events</p> | <p>sigma has undertaken many dissemination activities including:</p> <p>4 national conferences, with a 5th planned for September 2010. Since 2006, sigma and the HEA MSOR Subject Centre have organised an annual national CETL-MSOR conference. Each conference has a specific theme and runs over two days. The number of delegates has grown year on year and the 2009 conference was attended by over 130 delegates, with a small but growing number of international delegates. These conferences have helped to establish a community of practice across the UK and beyond.</p> <p>2 Higher Education Mathematics Education conferences, with plans for future events. Inaugural event held at Loughborough University in December 2008, 2nd event held at the University of Limerick, December 2009. These events were established by the sigma PhD Research Group as a way to disseminate their research as well as being a professional development activity.</p> <p>Keynote speakers at the "Addressing the Quantitative Skills Gap" Conference St Andrew's University June 2007. Over 30 delegates. Proceedings have been published: "Responding to the Mathematics Problem: The Implementation of Institutional Support Mechanisms." Editors C. M. Marr and M. J. Grove, and published by the Mathematics, Statistics & OR Network (2010).</p> <p>Keynote speakers at the 2nd & 3rd Irish Workshop on Mathematics Learning and Support Centres December 2007 and November 2008.</p> <p>Details of the series of sigma seminars held at LU and CU can be found in Appendix 1.</p> | | | | | | |

Part Two

Question 1

Please reflect on how effective your CETL has been in contributing to the objectives set out for the CETL initiative when it started. Be concise and do not exceed 1,000 words for the whole question.

- i: To reward practice that demonstrates excellent teaching outcomes for students*
- ii: 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*
- iii: To enable institutions to support and develop practice that encourages deeper understanding across the sector of ways of addressing students' learning effectively*
- iv: To recognize 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*
- v: To demonstrate collaboration and sharing of good practice and so enhance the standard of teaching and effective learning throughout the sector*
- vi: To raise student awareness of effectiveness in teaching and learning in order to inform student choice and maximize student performance.*

1.1 Rewarding Practice

Centre for Excellence status and the concomitant funding has, in **sigma**'s experience, been a significant development in rewarding practice that demonstrates excellent teaching. Being externally badged as "a Centre for Excellence" definitely increased the status within the host institutions of the pre-existing activity. The funding (in particular its size and longevity) meant that the CETL was taken seriously. The presence of significant funding for a 5 year period meant that **sigma** could not be ignored as a minor short-term project.

Initially there were some direct rewards to those staff who had been involved in the work leading to the CETL award through modest "bonus" payments. Since then direct financial rewards have been limited. All financial payments have to be in line with institutional HR policies which remain biased in favour of traditional achievements (PhD supervision, research publications, grant income). One of the co-Directors has been awarded a personal chair and the CETL award was a significant factor in achieving this. However, it should be noted that that this does not necessarily serve as an inspiration for others as the one-off nature of the CETL programme means that there are no longer opportunities for securing large scale funding for teaching and learning developments.

In addition to financial payments, staff engaging with **sigma** were rewarded by being able to purchase equipment to explore innovative teaching approaches, to attend conferences and engage in other developmental activities, and to have increased opportunity to supervise PhD students. Also, staff were offered opportunities to work with other academics and other institutions on collaborative projects. Most of these opportunities would not have been available were it not for CETL funding.

In terms of rewarding practice in the wider community, in 2009 **sigma** instigated the "[sigma prize for outstanding contribution to mathematics and/or statistics support](#)", the first winners receiving their award at the annual conference in September 2009. The prizes scheme is running again this year and efforts are being made to secure sponsorship for the future.

1.2 Embedding Change

CETL funding enabled practitioners to have time to reflect on developing new teaching approaches and to experiment with new technologies. This has led to change in practice on a considerably wider scale than just those staff directly engaged with CETL activities – particularly notable has been the successful championing of the use of electronic voting systems in both institutions.

The Eureka Centre for Mathematical Confidence was established with CETL funding. This Centre supports students with a severe lack of confidence, or phobia, in mathematics. The Centre

established a [Postgraduate Certificate on Dyslexia and Dyscalculia in HE/FE](#) and developed a dyscalculia screener to be launched by a commercial company in 2010.

1.3 Supporting Practice

The activities of **sigma**, both directly with students and in pedagogic research, have enabled the host institutions and the sector to increase understanding of issues relating to how non-specialist students learn mathematics. In particular, our work has reinforced the necessity to address the issue of engagement rather than simply focusing on provision of resources. The work of a CETL PhD student in evaluating the effectiveness of mathematics support has emphasised the fundamental importance of addressing engagement.

Other work has reinforced the impact of learner identities on effective learning of mathematics. This work has shown the importance of physical space in developing learner identities and has influenced the way in which **sigma** has utilised its physical estate.

The “spin out” projects (see Part A) highlight how **sigma** has worked to support the development of teaching practice across the sector.

1.4 Recognising Clusters of Excellence

sigma's two collaborating institutions hosted five CETLs. At each institution, there was fruitful interaction. For instance, a CETL Board, chaired by the PVC (Student Experience) was created at CU to disseminate CETL activities and outcomes and enhance practice across the institution. **sigma** was a member of the East Midlands CETL group. This group was particularly effective in the early stages of the programme, acting as a source of support and dissemination of practice. However, its role declined as the individual CETLs became more established and their agendas diverged.

1.5 Impacting the Sector

From its inception, **sigma** had a very outward facing role. A key element of the proposal was the establishment of support provision, similar to that already provided in the two host institutions, in other HEIs. Also, **sigma**'s original goals were to share resources it developed and approaches it piloted across the sector. This has been achieved to an extent *far greater* than originally imagined. In addition to the establishment of three new centres (all of which now continue with funding from their own institutions), **sigma** has created major momentum in the field of mathematics support. By inviting visitors to observe its practice, **sigma** has helped them to establish mathematics support provision in their own institutions.

Working with the Maths, Stats & OR Network (the Higher Education Academy Subject Centre) four successful conferences, each with over 100 delegates attending, have taken place. **sigma**'s secondment opportunities have been taken up by staff from a wide range of institutions (including some from overseas) and a pilot of **sigma** hub activity has been carried out. The success of this latter activity has been noted by the National HE STEM Programme and **sigma** is to be funded by this programme to develop a nationwide network of regional hubs.

The momentum provided by CETL funding has enabled **sigma** to add value to a range of previously funded activity (e.g. the LTSN project **mathcentre** and the FDTL/Gatsby project **mathtutor**). Additional external (i.e. non-CETL) funding has been secured to enable further developments of these projects – without CETL involvement these projects may have fallen by the wayside.

The pedagogic research undertaken by staff engaging with the CETL (see Annex A) has also impacted the sector.

1.6 Raising Student Awareness

Many thousand students in the host institutions have interacted with **sigma**. Feedback indicates that many attribute improvement in their performance to the opportunities that **sigma** has provided and some have stated that without the support provided by **sigma** they would have withdrawn from or failed their course. Some have indicated that being made aware of the opportunities for mathematics support influenced their choice of institution.

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 question.

The aims of **sigma** were to:

1. develop an environment in which it is the norm for all LU and CU students:
 - o To expect to succeed in the mathematical or statistical components of their mainstream studies;
 - o To rectify shortcomings in their mathematical or statistical knowledge; and
 - o To build confidence in their ability to apply mathematics and statistics in their mainstream studies;
2. promote the enhancement of the teaching and learning of the mathematics and statistics taught throughout LU and CU; and
3. stimulate and encourage growth of similar proactive activity across the HE sector.

Aim 1: **sigma** has undoubtedly improved the physical environment at LU and CU. Feedback indicates that students regard our physical estate as an attractive environment conducive to studying. Thousands of students have now used our facilities and taken advantage of the support provided. This has improved their chances of success, enabled them to rectify shortcoming and built their confidence. However, as has already been noted, there remains a significant number of students who would clearly benefit from interacting with **sigma** but who do not.

Aim 2: The presence of **sigma** and the services it provides for students has most definitely promoted the enhancement of the teaching and learning across LU and CU. The provision of enhanced teaching facilities, a wide range of equipment and new on-line learning resources have also contributed. Furthermore, the work of **sigma** staff in promoting the use of new technologies has led to widespread adoption of more active teaching and learning approaches.

Aim 3: **sigma** has acted as a catalyst, stimulating growth of a mathematics support community throughout in the UK and internationally. As a consequence of both the funding it has provided and the opportunities for interaction between staff, provision of mathematics support across the HE sector is at a *vastly improved level* compared to 2005. In this area, **sigma** can be seen to have achieved much more than originally envisaged.

Our original objectives (Appendix 2) were consolidated into six core "cluster groups" and other encompassing activities (Figure 1).

sigma activities

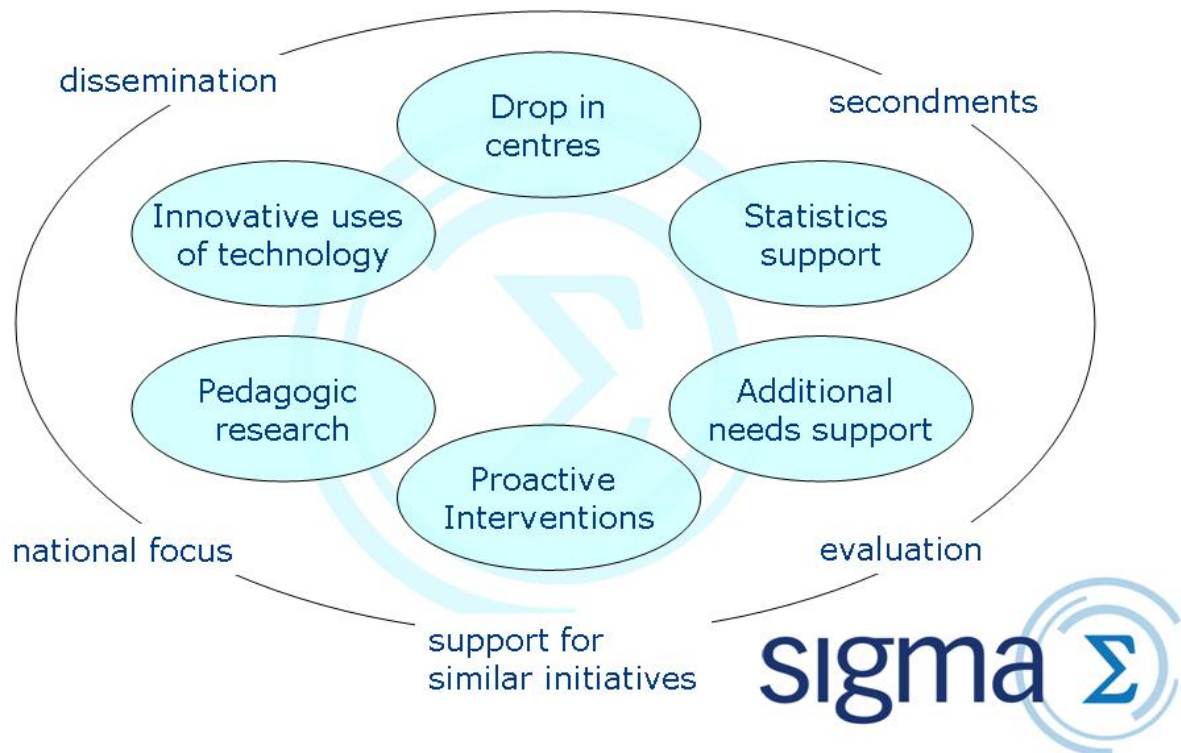


Figure 1: **sigma**'s core areas of activity

2.1 Drop-in Centres

In terms of core objectives, **sigma** has been successful in ensuring that all students at LU and CU have access to drop-in support. Usage of the drop in centres has increased year-on-year (Appendix 3). Whilst the core clientele has continued to be the "traditional" users (i.e. mathematics and engineering students), the number of students from other departments and faculties has increased. To encourage such students, **sigma** introduced outreach desks (in the Library and elsewhere at CU) as well as workshops and drop-in sessions in individual departments (Nursing and Midwifery at CU and Information Science at LU). Innovative marketing strategies have been employed, including using students to develop and deliver promotional activities. These have proved effective. Feedback from students attending drop-in sessions has been extremely positive (Appendix 3).

2.2 Statistics Support

The Statistics Advisory Services (SAS) have been a great success (see Appendix 4). These offer one-to-one appointments and a series of workshops that were originally focussed on postgraduate students but were widened to include staff due to high demand. In order to ensure effective use of the appointment based service, drop-in sessions have been added to deal with routine queries. The SAS at both institutions has out-performed its targets year-on-year. Ongoing demand and feedback indicate that this a high valued service. Demand will continue to grow as postgraduate numbers rise and as disciplines place more quantitative demands on them.

2.3 Additional Needs Support

The development of specialist support for students with additional needs has been particularly successful at LU (Appendix 5). The establishment of the Eureka Centre at LU (including dedicated space) has given this support a clear focus and allowed the provision to be extended to include one-to-one appointments, workshops and study space. The success of this provision has led to spin-off projects with the LU School of Art and Design as well as with Shirley Conran's [Maths](#).

[Action not-for-profit organisation](#). Efforts have been made at CU to create a similar service but the lack of dedicated space and staff has affected its success.

2.4 Proactive Interventions

Another key element of **sigma's** work has been to move the balance from reactive to proactive support through a range of activities known as Proactive Teaching Interventions (PTIs) (see Appendix 6). These have provided excellent staff development opportunities for staff undertaking secondments with **sigma**. Several interventions enabled staff to integrate new technologies into their teaching. In general, where students have been identified as at risk of failing and have been provided with alternative learning opportunities, outcomes have not been as good as we would have hoped. There is some evidence that it is not a good idea to select weaker students and teach them separately. Where students self-select, engagement is much better; however, the very students that **sigma** needs to engage with most are the least likely to self-select.

2.5 Uses of Technology

Through capital funding, **sigma** purchased several items of technology for evaluation in terms of effectiveness in teaching and learning. In addition, mini-project funding was made available within the host institutions and the wider HE sector to enable others to undertake similar evaluations. More in-depth usage and evaluation was limited to specific technologies, including personal response systems, PDAs (specifically in a "numeracy for Nursing" context) and robotic LEGO®. As well as innovative uses of technology, we investigated innovative delivery of resources, e.g. through non-traditional channels such as iTunesU.

2.6 Pedagogic Research

Our work has been underpinned by a programme of pedagogic research. Areas explored have included mathematics support, uses of technology in teaching, and student experiences of learning mathematics at university. Findings have been published in journals and conference proceedings (Annex A). **sigma** has funded one successful PhD student who completed in 2009. A second will complete in 2010. A further student who transferred-in part way through her research will complete in 2010. One student completed an MPhil. Three others dropped out without gaining a qualification.

Question 3

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

Once the work of **sigma** began to develop, our focus widened to include the following:

3.1 Developmental / employment opportunities for students

sigma has worked directly with students through:

- summer internships,
- student proctors employed to offer support within the drop-in centres,
- sandwich placements
- involvement in the Nuffield Science Bursary scheme,
- peer assisted learning support project
- student ambassadors employed to help develop and deliver targeted campaigns publicising the services offered to their peers
- Artwork design competitions included and assessed as part of specific Art and Design modules

See Appendix 9 for examples.

3.2 Widening the impact of CETL funding

sigma has funded nine secondments, with six secondees coming from outside LU/CU. Some of the secondments fed into the Proactive Teaching Interventions, whilst others focussed on technical skills development, generic resource development or piloting new provision. All secondees have been encouraged to present their work at the CETL-MSOR Conferences and to publish papers in MSOR Connections.

sigma has worked closely with several academics through its Visiting Fellows scheme. This has enabled individuals to link with **sigma** members to work on research projects, including the development of a series of motivational sessions for the second year mathematics students and the learner identities of mathematics students and their use of social learning spaces.

3.3 Hub network

An unexpected outcome of our outreach programme has been the creation of the **sigma** regional hub network. The key purpose of the hubs is to provide local access to **sigma** events and workshops. In addition, they aim to:

- Facilitate the sharing of information and materials across their constituency
- Build a local network for those interested in mathematics support
- Co-ordinate views from the local network to feed into an annual forum

Two hubs were established as part of the initial pilot; the South West Hub is co-ordinated through the University of Bath and the Scottish Maths Support Network is co-ordinated through St Andrews and Glasgow Universities. Both hub networks continue to hold events to promote mathematics support. A new hub covering the North East and Yorkshire co-ordinated by Leeds and Sheffield Universities has just been established. **sigma** has also been involved in the establishment of a similar network in Ireland.

3.4 **sigma** prizes for outstanding contribution

In 2009, we instigated the [sigma prizes](#) as a way of recognising those, outside the two collaborating universities, who have made sustained and valuable contributions in the field of mathematics and statistics support. A [similar award scheme for 2010](#) has been launched, with the prizes to be awarded at the 2010 national conference.

3.5 International impact

sigma has had a notable impact internationally. Following visits to **sigma**, the [first mathematics support centre in Switzerland](#) has been set up at the University of Applied Sciences North West Switzerland. A strong network of mathematics support staff has been established in Ireland with significant input from **sigma** staff. Good working relationships have been developed with colleagues in Australia, across Europe (through an EU funded project in which **sigma** was the “expert” partner), in the Middle East, Far East and Africa.

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 internally and externally, on professional/staff development, on student learning, work over an extended period, use of money for facilities development etc.)

4.1 Achievements with students

sigma has been successful in achieving most of its original objectives. We have been able to create an environment where students at LU and CU have access to the support they require to help them improve their mathematical or statistical knowledge. The support on offer is of extremely high quality and has been praised in QAA Institutional Audit reports [1,2]. The statistics support provision has been of benefit to staff as well as students. The statistics workshop provision at CU had to be extended to two runs per academic session due to heavy demand from staff members. Innovative ways of supporting students have also been piloted, including the provision of online support via the Elluminate® application, which we were able to link with similar work being undertaken at the Open CETL. Dr Tim Lowe gave a virtual presentation of his work at the OU using Elluminate to **sigma** staff.

As well as direct student support, **sigma** has continually sought wider student engagement, for example through its student ambassadors and summer interns programmes. Both of these programmes have enabled **sigma** to work with students on promotional, developmental and evaluation activities, which, in turn, have proved beneficial to the personal development of the students. In addition, **sigma** has worked with the Nuffield Science Bursaries Scheme to provide project placements for Year 12 school students working on mathematics and statistics related research and resource development projects. One of these projects has led to the development of workshops using LEGO® MINDSTORM NXT robots, aimed at showing practical applications of mathematics to Year 11 students, which was then used by the "[More Maths Grads](#)" project as part of their activity portfolio with schools in the West Midlands. Employing students on placement has also benefited both the institutions and the students involved.

One of the most challenging objectives relates to the reduction of failure and referrals on mathematics and statistics modules for non-specialist students. This is because it is extremely difficult to draw a direct causality between the services and support provided by **sigma** and assessment results, other than through anecdotal evidence. **sigma** has however succeeded in providing every opportunity to students who want to improve their mathematical and statistical understanding. In addition, an evidential and research base for the evaluation of mathematics support provision is being developed and made available on <http://www.mathcentre.ac.uk/staff/types/research-papers/measuring-the-effectiveness-of-support-centres/>.

4.2 Achievements for students with additional needs

One of the benefits of CETL funding has been the focus it has provided in terms of the development of support for students with additional needs. The capital spend enabled **sigma** to establish a unique space to support students with additional needs as well as those with anxiety towards mathematics. This also enabled the development of the Postgraduate Certificate in Dyslexia and Dyscalculia in HE/FE. Seven students successfully completed the first running of this award and there are nine students enrolled on this year's intake.

4.3 Achievements with staff

sigma has worked hard to ensure that the benefits of CETL funding were extended as far as possible. This has been achieved by offering staff at the host institutions and beyond secondment opportunities, access to technologies, support for teaching innovation and providing the opportunity to undertake professional development activities. One key benefit has been the widening of the statistics support (originally envisaged for postgraduate students) to staff – there was an unexpectedly high demand for access to the statistics workshops, for example.

4.4 Dissemination and external impact

The effective dissemination of **sigma**'s work, its collaboration with the MSOR Subject Centre of the Higher Education Academy in running a highly successful annual conference and its establishment of mathematics support centres in three other universities have helped to create a firmly established "**sigma** brand". This brand has been reinforced by the creation of **sigma** regional hubs, the support provided for the establishment of the All-Ireland Mathematics Support Network and the support offered to institutions in the UK and internationally. The **sigma** brand is associated with Loughborough and Coventry Universities and is valuable in terms of national and international reputation.

4.5 Attracting funding

sigma has been able to leverage its reputation to gain funding on several other projects:

- [an EU Leonardo project](#),
- [a JISC RePRODUCE project](#),
- JISC funding to upgrade the [mathcentre](#) and [math tutor](#) websites,
- funding to develop the pilot [statstutor](#) website project, and
- involvement in the [JISC OER Programme](#) through [the FETLAR project](#).

In addition, the choice of CU to be one of the regional partners in the More Maths Grads project was strongly influenced by the presence of **sigma** at Coventry.

4.6 Achievements with technology

Using the CETL-funded recording facility at CU, new video resources have been developed. These extend the materials produced by the **math tutor** project with which the **sigma** team were associated. These videos can be streamed over the internet and, in addition, downloadable versions suitable for video iPods, MP4 players and 3G mobile phones are being provided. These resources give students the opportunity to access support in a new way, using mobile technology to enable them to receive high quality tuition in small "bite sized" chunks at times and locations most convenient to themselves. Moreover, this has enabled us to test other channels for dissemination, such as iTunesU. Many of the resources developed have been made freely available over the internet. The success of the video tutorials released through iTunes and the unsolicited feedback received through the **mathcentre** site show that **sigma** activity has made a positive contribution to a large number of students around the world.

Providing access to technologies has not only enabled evaluation and research but also professional development opportunities across **sigma** and beyond. For example, **sigma** staff have been instrumental in the demonstration and promotion of electronic voting systems. Staff from across a range of disciplines at both institutions are now showing great interest in this technology and **sigma** staff are at the forefront of its adoption and evaluation. The foundations laid by this CETL activity have provided a catalyst for staff to bid successfully for additional funding to disseminate and share expertise with staff in other disciplines.

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)

The **sigma** team believes that it has had considerable achievement in key areas, but tempers this belief with disappointment that we didn't achieve even more.

5.1 Proactive Teaching Interventions (PTIs)

Significant effort was expended on developing PTIs, whereby student groups with particularly poor records of mathematical progress were targeted with various innovations – e.g. alternative teaching methods. Despite novel alternatives or additions to current provision (use of technology, empathetic teaching staff, small groups) a significant number of students failed to engage to the extent that most were discontinued in later years. Effort was also expended in trying to find out more about *why* these students did not engage. A **sigma**-funded PhD student (Symonds) focused on this aspect [3]. We have learned a lot, and reported findings, about the need to focus much more on student engagement.

Nevertheless, there were notable successes and the [Summer 09 edition of the sigma newsletter](#) reports on some of these.

5.2 Postgraduate Students

sigma is pleased that, already, one **sigma**-funded student has completed her PhD. Journal publications have resulted. Another **sigma**-funded student has been awarded an MPhil. Two students are expected to complete PhDs this year. It has been frustrating that three left prematurely (one because her husband moved abroad, and two to take up work-related opportunities).

We have been frustrated with the difficulties we have experienced in recruiting PhD students. We believe this is due to the following factors:

- (a) The nature of this work (combining mathematical with educational and research skills) does not lend itself naturally to a ready supply of postgraduate students;
- (b) It is not clear to potential candidates whether there will be many post-qualification opportunities; it is likely that students who gain PhDs in pedagogic research will have difficulty in gaining traditional academic posts (e.g. in mathematics departments). It is also unlikely that our students could expect to move to traditional education departments if they apply for post-doctoral positions.
- (c) In the early stages, a lack of reputation in formal pedagogic research within the two collaborating centres may have hindered recruitment.

Nevertheless, it has not all been disappointing - the CETL provided sufficient momentum for 7 staff to be returned at the 2007 RAE, a Professor of Mathematics Education and more lecturing staff have been appointed and there is now a viable (non-CETL funded) PhD student group working in mathematics education at LU.

5.3 Staff recruitment

It has been difficult to recruit/retain staff. Being a Centre for Excellence it has been important to endeavour to recruit staff with a good record in teaching/pedagogic research/ innovation.

It has proved difficult to recruit statisticians notwithstanding the fact that one of our main aims was to develop statistics support. Re-advertisement was necessary and the pool of applicants small (particularly back in 2005).

Whilst CETL funding was undoubtedly welcome by those involved with **sigma**, its five-year nature introduced a systemic problem given that fixed-term contracts would not be attractive to potential candidates already in permanent posts.

When seeking to fill research assistant/research fellow posts, we were fishing in a small pool of suitable applicants. The post of Senior Research Fellow was eventually filled in 2005, but only after re-advertising. Few are engaged in practitioner-based pedagogic research and the applicant lists were small.

Despite these staffing difficulties we believe there is substantial evidence of the impact of **sigma** staff throughout the sector and of their contribution to practice and knowledge in the field.

Question 6

Please reflect on the difficult and easier aspects of getting the CETL going and of getting your message 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 Support from Senior Management

At both host institutions, strong support from senior management (Vice-Chancellors, PVCs) from the outset helped to establish the CETL and provided **sigma** with a strong base position. This support has continued throughout the life of the project and has helped to secure future funding for mathematics and statistics support post CETL funding.

6.2 Cultural Change

The CETL initiative, being quite foreign to universities, not surprisingly encountered difficulties especially at the start. Its priorities were alien in many ways to the prevailing culture and ethos. Wanting to recruit, promote or otherwise reward staff whose primary interest was in teaching brought to the fore issues concerning the parity or otherwise of teaching and research. Likewise, wanting to encourage a wider group of staff within the institution to engage with a teaching-led or student support agenda proved problematic.

6.3 Estates

There were difficulties at the start with finding suitable space, and once found, adapting that space sufficiently quickly to get the CETL moving. Having to wait in-line along with existing university projects caused understandable but nevertheless frustrating delays. In retrospect, it may have been beneficial to have employed someone in the first two years to deal solely with the capital funding, that is looking after the procurement processes and "stock management" as well as estates and building works. Much of the time of core **sigma** staff in the first two years was taken up with ensuring that the capital funding was spent and all works completed; by employing someone to take responsibility for this element, more could have been done to get the actual work of **sigma** established more quickly. This was also impacted on by the absence of the previous Assistant Director through long-term illness, her subsequent resignation and the need to recruit again during this time.

6.4 Capital Spend

The HEFCE-imposed limit of capital spend to the first two years of the project was an issue. One of the key areas of work for **sigma** was the investigation and evaluation of new technologies so the limitation greatly curtailed some of the work we could have done, for example, with mobile devices such as the iPhone. It also meant that some of our kit became obsolete and we were unable to replace it.

6.5 Staff recruitment and retention

Recruitment and retention of staff and postgraduate students has proved problematic throughout the duration. In particular, the attraction and retention of statisticians and researchers proved very difficult. The ability to reward staff was also difficult. Due to the strictures of each of the host institutions' HR policies, reward was restricted to conference attendance and some professional development courses rather than a more deep rooted change to the system of recognition and reward for teaching.

6.6 Engaging and enthusing staff

Encouraging colleagues outside the CETL's host institutions to become involved in our work was sometimes easier than recruiting internal colleagues. This is partly because the kudos that comes from establishing links and gaining small project funding from a CETL such as **sigma** seems to be greater externally than internally. Also, there have been problems engaging with Mathematics Department staff who are research focused and who do not see their teaching as a top priority, especially where there are additional pressures to ensure research output is maximised.

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)

The initial proposal for **sigma**'s activity did not draw on any explicit theoretical perspective or model. Rather practice was shaped by the long-standing experience of practitioners that relied heavily on a pragmatic approach i.e. the "what works agenda". Theoretical grounding was based on tacit knowledge and largely implicit.

As **sigma**'s work has progressed there has been opportunity for greater reflection and interaction with educationalists and this has influenced the approach we have adopted. The importance of the establishment of communities of learners, building on the work of Etienne Wenger (1998) [4], has been a key theme that has emerged. Wenger's work can be located within the theoretical perspective of social learning theory. Alongside this, and central to promoting effective communities of learners, is the need to secure high levels of student engagement. **sigma** had identified with the broad-based concept of student engagement, as articulated by Fredricks, Blumenfeld and Paris (2004) [5], and seeks to promote student learning through fostering engagement at the cognitive, emotional and behavioural levels. A final strand that has emerged is the whole issue of learner identity – particularly of identity as a mathematician. This issue of identity has different manifestations in those who are specialist mathematics students and those who are not, but who are required to study some mathematics. Sigma is of the view that the theoretical underpinning offered through social learning theory generally, and drawing on conceptual analyses addressing communities of practice (learners), student engagement and learner identities, is central to effective learning.

sigma's Senior Research Fellow undertook research into the nature and development of the mathematics support community in the UK based on the a theoretical framework of cultures of academic disciplines developed by Becher (1989) [6] and Craig (2003) [7]. Within such a framework, mathematics support has the status of a practical discipline.

sigma's Proactive Teaching Programme combines a number of educational theories. Jean McNiff's (2002) [8] theory of action research has informed the approach taken by some **sigma** staff to evaluate and improve their interventions on an annual basis. The use of electronic voting systems for the foundation engineering intervention has been influenced by the experimental research of Draper and Brown (2004) [9] and Nicol and Boyle (2003) [10]. The discrete mathematics intervention has used a variant of the Computer-Assisted Personalised System of Instruction (CAPSI) developed for the subject at Brunel University by Brinkman, Rae and Dwivedi (2007) [11]. This is based on Kinsner & Pear's (1988) [12] development of CAPSI which is based on Keller's (1968) [13] original Personalised System of Instruction (PSI). PSI is itself based on Skinner's (1961) [14] theory of Programmed Instruction.

sigma's work with new technologies has been influenced by a number of educational theories including Hartley's (2007) [15] theory of the different social uses of technology and Sharples, Taylor & Vavoula's (2007) [16] application of Engeström's (1987) [17] Activity Systems Theory to derive a theory of mobile learning. **sigma**'s use of robotic kits to embody mathematical concepts has been influenced by the theory of Lakoff and Nunez (2001) [18].

A **sigma**-funded PhD student is investigating the influence of mediating and moderating effects in mathematics support based on the theories of Gollwitzer (1999) [19] and Webb and Sheeran (2007) [20].

Another **sigma**-funded PhD student is investigating the relationship between the use of modes of mathematics support, approaches to studying and mathematical performance based on the theory of approaches to studying originally developed by Entwistle (1988) [21] and Ramsden (1997) [22], and later refined by Case and Marshall (2004) [23].

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)

The important messages about **sigma** are that:

1. It has been a catalyst for improvements in mathematics support in universities throughout the UK and around the world;
2. There is an ongoing demand from postgraduate students across our two universities for a Statistics Advisory Service (appointments and drop-in) and such a service is valuable and appreciated. Demand for statistics workshops and support also extends to staff.
3. There is great demand for mathematics support resources, delivered using media that students are familiar with such as iTunes.
4. It has laid the foundations of pedagogic research in mathematics support and published widely;
5. Students have responded positively to the flexible modes of support offered through our drop-in centres, but engagement of the "hard to reach" minority remains problematic.
6. Recruitment and retention of postgraduate students in the relatively new field of practitioner-based research is challenging and, to sustain this activity, better career pathways need to be developed so that we can draw from a larger pool and potential recruits can identify careers they can aspire to.
7. Bringing about institutional change is a long, slow process, and further drivers will be needed if teaching/research parity is a real objective of HEFCE.

When reflecting on the successes of **sigma**, there are several which come to the fore: it goes without saying that at LU and CU "mathematics support" embraces a highly regarded and well-supported range of activities. But **sigma** has also been hugely influential in moving mathematics support up institutional agendas at many other universities. The new funded centres at Leeds, Bath and Sheffield Universities themselves have been catalysts for further innovation and were the seeds of the regional hubs concept. The **sigma** hubs provide events such as workshops together with practical advice and resources to mathematics support practitioners close to their home institutions. The Scottish Mathematics Support Network (St Andrews and Glasgow Universities) and All Ireland Mathematics Support Network arose directly from the work of **sigma**.

Such has been the success of the funded centres and hub models, the [HE STEM Programme](#) is now working in partnership with **sigma** to extend these activities. With new funding of £295,000 over three years, **sigma** will facilitate the setting up 4 new centres, and 6 regional hubs. A key message is that **sigma** has been the catalyst for improvements to student support at many other institutions and will continue to be so post-CETL funding until at least summer 2012. Many thousands more students and their teachers will be supported. **sigma** has harvested and developed a massive volume of mathematics support resources (some 800+ resources have recently [by Spring 2010] been deposited in the JORUM repository) and all of these are freely available and widely used. We believe that collectively these efforts have had major impact upon the quality of the student experience.

An important lesson is that there are still significant numbers of students who are not inspired to engage with additional opportunities designed to help them succeed. [Perhaps an important national message is that some disciplines need to be more explicit about the importance of the mathematics they require students to learn, and to be more selective in who they recruit to their courses!]

On the other hand, very many students have enthusiastically embraced the facilities and services on offer in the mathematics support centres. We have plenty of documentary evidence about the value of the learning space in shaping their mathematical identities. The continual rise in usage of the drop-in centres is clear evidence that many students do want to learn and seek support, but at a time of their choosing. A key message is the continuing need for more flexible mechanisms of support – mechanisms which will appeal to the 21st century student.

To bring about wider institutional changes requires many groups to be persuaded of the value of the change and many individuals, at all levels, to be inculcated with the ethos. This can be very difficult because there is considerable inertia in the system and many competing priorities. Consequently fundamental change is usually a slow process taking several years. Many staff in higher education are used to a system in which subject-based research is a pre-eminent driver. For teaching, learning and student support to become a priority requires not only a change in institutional strategies, it also needs there to be a culture change driven by all levels of management, not just the most senior. The substantial nature of CETL funding was certainly influential in starting a process of change, however as it became clear that there would be no further funding of this nature this influence was reduced.

We now have evidence that senior management in our host institutions have been convinced of the value of **sigma's** work. At both institutions, CETL continuation proposals have been well-received and continuation funding has been secured.

But five years is not a long time to bring about institutional change unless such change is driven by the institutions' strategic priorities. It is only in the last couple of years that we have been able to start to turn the early work of **sigma** into a more substantial body of knowledge and transferable outputs. An important message is that ongoing efforts will be required if the lessons learned and progress made are to be consolidated.

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)

It has been our experience that, after the initial "set-up phase" there has been only very limited interaction between CETLs. With hindsight this would seem to be a wasted opportunity. It was unfortunate that there was not a greater degree of co-ordination across all the CETLs from HEFCE or the HEA, particularly in common areas such as the use of technologies, innovative teaching practices. It was left up to individual CETLs to establish collaborative links and information exchanges. There has been a missed opportunity for pulling together learning from across all CETLs. Furthermore, the lack of any such central co-ordination meant that the impact of "the CETL movement" across the whole of HE, particularly in terms of raising the status of teaching, was greatly diminished.

9.1 East Midlands CETL Network

In 2005, nine of the CETLs in our region collaborated to form the East Midlands CETL Network. These are the nine CETLs based at the Universities of Leicester, Loughborough, Nottingham and Nottingham Trent. The Network had a common goal of enhancing the student experience and its primary aims were to promote sharing of best practice, innovation, reward and recognition of practitioners. The Network, at its launch event, drew attention to the fact that the CETLs represented an investment into the region of around £32 million. In the early days, the Network provided valuable mutual support for members whereby experiences of start-up issues could be shared. An offshoot has been the East Midlands Pedagogic Research Network for which the engCETL at Loughborough hosted a pedagogic research workshop in July 2007.

9.2 Involvement with Other CETLs

As the CETLs matured there was less collaboration and there has been little activity in the later years though representatives still sit on other CETL advisory boards/ steering groups. Professor Duncan Lawson, the Coventry Director, has been a member of the Advisory Board for COLMSCT, part of the OpenCETL. **sigma's** external evaluator, Dr Stephen Hibberd, is Associate Director of the Centre for Integrative Learning (CETL) at the University of Nottingham. Professor Tony Croft is on the Advisory Board of the CELS CETL at Nottingham Trent University. Thus there is input to **sigma** from the wider CETL community and **sigma** is able to share some of its experiences through these channels.

sigma has run four successful Annual Conferences wherein a dominant theme is mathematics and statistics support. The first two conferences were organized jointly by **sigma** and the MSOR Network. For the third conference, the Postgraduate Statistics Centre, a CETL-based at Lancaster University, joined the organizing committee. Likewise, for the fourth conference, COLMSCT (part of OpenCETL at the OU) also became involved. The location of the conferences has rotated through Loughborough, Birmingham, Lancaster and the OU at Milton Keynes.

Working with the MSOR Network, **sigma** has helped to organise two "show and tell" days for CETLs with any interest in the mathematical sciences. In addition to the three CETLs involved in the annual conference, the RLO CETL, LearnHigher, Centre for Integrative Learning and piCETL have been involved in these events. Although attendees at both events declared their intention to collaborate in areas of shared interest, in reality virtually no such collaboration took place.

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.

Transferable outcomes from **sigma** fall broadly into the following categories:

- Lessons learned from the enhancement of the provision at CU and LU;
- Creation of new resources and materials as well as the investigations of the uses of technologies to support teaching;
- [Research into the effectiveness and the pedagogy of mathematics and statistics support](#);
- [Work done on proactive teaching interventions](#); and
- The development of a community of mathematics support practitioners through our growing national (and international) presence; the creation of local hubs and new centres for Maths Support in HEIs, and through the annual CETL-MSOR conferences

10.1 Sharing Our Experiences

As mentioned previously, **sigma** has been happy to provide support and guidance to other institutions that are looking to establish similar provision. One of the benefits of this is to advise others of lessons learned from the development of the provisions at LU and CU. The groundbreaking work we have undertaken in the provision of statistics support for students and staff is a useful model for other institutions to adopt.

10.2 Resources and Materials

The learning resources created by **sigma** are used not just by those undertaking mathematics or statistics based degree courses but a much wider audience, including school pupils, FE students and employees needing support for their professional development. Access to these resources has been widened to include non-traditional channels such as iTunesU. The funding of the updating of the extremely popular *mathcentre* website as well as the development of its sister site www.statstutor.ac.uk underlines the importance that the HE sector places on the delivery of freely available materials through a trusted channel. The lessons learned from the success of adopting such approaches and investigating the uses of different technologies in the teaching and learning of mathematics is easily transferrable to other areas.

10.3 Proactive Teaching Interventions

By moving from a reactive to proactive approach to the support of students, the Proactive Teaching Interventions programme has highlighted a number of lessons learned that could easily be applied to other contexts. Key messages from this work can be found in the Summer 09 **sigma** newsletter (which can be found at <http://www.sigma-cetl.ac.uk/index.php?section=96>).

10.4 Building a Community

In **sigma**'s original bid, a commitment was made to establish mathematics support provision at three further HEIs during the period of CETL funding. This has been achieved. Centres have been established at the universities of Bath, Leeds and Sheffield. However, **sigma**'s external activities have extended far beyond the setting up of these new centres. **sigma** has become the focus for the development of a community of practice for staff involved in mathematics support. **sigma** has played a big part in developing the community through its annual conference. By moving its location each year, this event is more reachable by a wide range of academic staff. In a further development, the **sigma** PhD training group has become a focus for the HE Mathematics Education Research Community through its two [HEMEC conferences](#).

In addition, the funding of new mathematics support provision in other universities, the funding of secondments and mini-project, the creation of prizes to reward contribution to the field and the establishment of the pilot regional hub network have all contributed to a growing and dynamic

international mathematics support community. Our experiences have already been mirrored in the [National HE-STEM Programme](#), which has adopted a “hub and spokes” model to its organisation across the country (although a different terminology has already been established - what are called “spokes” in the National HE STEM Programme are called “regional hubs” in the **sigma** network). There are discussions within the LDinHE network at the moment around the creation of local support networks, particularly in support of CPD activities, and **sigma’s** experience could help to inform any developments in this regard.

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 of any structures have been put in place to ensure its legacy is not lost.

11.1 Continuation Funding

A major achievement for **sigma** is that much of its academic and support work locally will continue after the end of CETL funding in July 2010. With both host institutions making significant financial commitments and with the acquisition of external funding, both the internal direct work with students and the external promotion and development of mathematics support will continue.

At both LU and CU, the enhanced provision achieved under **sigma** is now well embedded. Central funding has been approved to enable much of the enhanced level of support service developed by **sigma** to be continued. At LU, this includes the continuation of the availability of support at current locations across campus, of the Statistics Advisory Service and its associated workshops (including the creation of a new statistics lecturer post) and of the additional needs support provided through the Eureka Centre for Mathematical Confidence. At CU, this includes the continuation of support at its current location as well as the establishment of a new support location, probably within the Library, the continuation of the Statistics Advisory Service and its associated workshops and some continued work with students in the direct provision of support. At both institutions, this service has been linked up with the appropriate Teaching and Learning committee for reporting and review purposes.

11.2 Strategic Influence

At both host institutions, the provision of mathematics and statistics support is explicitly included in strategy documentation. At LU, it is included in the "Towards 2016- Strategic Plan" [24]; at CU, it is included in the current Learning and Teaching Strategy.

Externally, the impact and influence of **sigma** will also continue. At Leeds, Bath and Sheffield Universities, the mathematics support provision initially funded by **sigma** has also received central continuation funding and again this provision has been tied into the teaching and learning strategies of each institution. Both CU and LU will continue to provide support and advice to other HEIs interested in developing their own mathematics support provision.

The pilot work undertaken to develop a regional hub network is to be continued through funding from the national HE STEM programme, with **sigma** contracted to provide the mathematics support element of the programme. The funding allows for the continuation of the annual conferences for the next three years.

11.3 Course Developments

At LU, the Postgraduate Certificate in Dyslexia and Dyscalculia in HE/FE is continuing, with a new intake in January 2010. This is a direct legacy of the funding provided for the Eureka Centre for Mathematical Confidence.

Changes to teaching methods implemented as a result of working with **sigma** will continue, including the use of electronic voting systems, provision of narrated lectures, video based support resources and so on.

11.4 Working with students

It is expected that the work relating to using students in peer support activities, such as Peer Assisted Learning or proctor work, will inform student engagement developments at both institutions.

11.5 Resource Development

The upgrading of the *math*centre and *math*tutor websites as well as the development of sister site, *stats*tutor, will ensure that availability of resources will continue into the future. It is hoped that further funding can be gained to continue the development of *stats*tutor.

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)

In the seminal report, Making Mathematics Count, The Report of Professor Adrian Smith's Inquiry into Post-14 Mathematics Education (2004), Professor Smith stated:

"The higher education sector and the learned and professional societies have made clear to the Inquiry their serious concerns about the interface and transition between A-level mathematics and university courses heavily dependent on mathematics, such as degree courses in mathematics and statistics, or in physics, electronics, engineering and economics. In the short-term, the Inquiry believes that Higher Education has little option but to accommodate to the students emerging from the current GCE process."

Whilst there have been several initiatives aimed at improving mathematics teaching in schools (e.g. NCETM), and there have been efforts to improve the take-up of advanced mathematical qualifications (e.g. Further Mathematics Support Programme), Professor Smith's statement about needing to accommodate students emerging from pre-university education is as true today as it was in 2004. There is every expectation that there will be many students embarking upon higher education courses who find mathematics and statistics intimidating or who are ill-prepared for the mathematical aspects of their chosen courses. Consequently, the key CETL activities of working directly in the support of students and the staff who teach them, and the development of new modes of support will undoubtedly continue to have great importance in the future.

The National HE-STEM programme has already identified mathematics as one of the barriers to success in the STEM disciplines and has recognised that mathematics support is an effective way of helping many to overcome this barrier. Consequently, the programme is funding **sigma** to build on the success of its pilot regional hub in the south-west of England to create a network of **sigma** regional hubs throughout England and Wales. These regional hubs will work to promote interaction, collaboration and sharing of good practice between HEIs in the locality. As part of this work, **sigma** will establish the **sigma** Mathematics Support Network to enable exchange and collaboration nationally and to disseminate internationally emerging good practice.

In 2009 the Higher Education Academy stated that student engagement would be one of its three key priorities. HEFCE is supporting the HEA and the National Union of Students to deliver a joint project on student engagement. The aim is to better engage students in shaping their learning experience. **sigma** has undertaken a great deal of work directly with students, for example through its student ambassador and student intern programmes. Thus lessons learned may be used to inform future developments, particularly in terms of models for working with undergraduates.

Throughout the last five years, **sigma** has sought to exploit new technologies in the provision of mathematics support. Two of these appear to have great importance and this is likely to grow in the future. These include:

1. The delivery of mathematics support resources through not specifically academic mechanism – in particular iTunes and YouTube. The first set of short mathematics instructional videos that were made available on iTunes were downloaded at an astonishingly high rate.
2. The delivery of "one-to-one" or "one-to-few" mathematics support remotely via the internet using conferencing technology such as Elluminate. This is something already used by the Open University where the focus is clearly on remote provision, but it appears that it has significant appeal in more traditional HEIs to enable students to have greater flexibility in their learning.

Question 13

Any other comments (600 words maximum)

Comment from **sigma**'s External Evaluator, Dr Stephen Hibberd, University of Nottingham:

"The CETL-**sigma** award provided the funding opportunity to realise a vision for supporting teaching and learning in mathematics to capitalise on the existing good practice in student support at Loughborough University (LU) and Coventry University (CU) and on personal collaboration between the two directors. Throughout the project, both LU and CU senior staff were strongly supportive, well informed, and recognised that **sigma** was achieving its objectives and looked to strong heritage to be utilised to significant effect in their own Institutions. An outcome has been a substantial contribution in the support of students across the breadth of university programmes of study at LU and CU. **sigma** has redrawn the boundaries for Mathematics support and made provision of Mathematics support an expectation for a student HE experience, not just for Mathematics or strongly mathematics-related subject areas but for many less traditional subject areas requiring high numerate capabilities. Increasing pedagogic research is underpinning the developments in teaching support and the work disseminated within a range of journal and other publications will remain invaluable. Foundations for broader activity within the UK were laid by providing **sigma** funding from the start to help Support Centre starts at other Universities and develop a network to support and enhance more widely a Mathematics support agenda."

Comment from **sigma**'s Internal Evaluator, Dr David Green, Loughborough University:

"Of the many **sigma** evaluations which were undertaken, the three which stand out particularly are:

- (a) student feedback on support provided at the drop-in centres
- (b) **sigma** staff feedback on their involvement in the CETL's work
- (c) other academic staff feedback who worked with **sigma**.

Student feedback has been obtained through anonymous questionnaires issued each semester to samples of those attending the two drop-in centres at LU and the one centre at CU. Analysis of these has revealed a remarkably high level of satisfaction and appreciation of the support they have received. This has been consistent over the life of the CETL, which is particularly impressive in the light of the fact that numbers attending have increased significantly. Particularly valued has been the one-to-one help, and having a quiet place to study with a tutor on hand as and when required.

The **sigma** staff at both LU and CU were all interviewed annually, and two findings stood out: (i) their high level of commitment and enthusiasm for pursuing **sigma**'s objectives (ii) the considerable demands made on all those involved in achieving the CETL's objectives. The 'rewards' of CETL status certainly came at a price!

Although the numbers of non-**sigma** academic staff at LU and CU who engaged with the work of the CETL was limited, those who did clearly valued the opportunity and gained much from the experience. They have become 'ambassadors' for **sigma** in their own departments, and will provide valuable links beyond the life of **sigma**, which will be a lasting legacy."

Annex A

The full list of all publications to date can be found at:

http://www.sigma-cetl.ac.uk/index.php?action=download_resource&id=305&module=resourcesmodule&src=%40random479726d7c3e4a

This link opens a detailed Microsoft Excel spreadsheet

Appendix 1: sigma Seminar Series

Listed below is the series of **sigma** seminars held at LU and CU (note that all supporting documentation for most of these seminars can be found at <http://www.sigma-cetl.ac.uk/index.php?section=76>):

| Date | Title | Presenter |
|----------|---|--------------------------------|
| 29/11/06 | VLE Case Study | Dr Peter Samuels (CU) |
| 29/11/06 | Virtual Learning Environments | Dr Sue Moron-Garcia (LU) |
| 15/12/06 | Computer Algebra Systems | Dr Zsolt Lavicza (Cambridge) |
| 31/01/07 | Maths Support Centres | David Bowers (Suffolk College) |
| 04/05/07 | Student Involvement | Nuzhat Qadri |
| 04/05/07 | CAL '07 | Dr John Goodband (CU) |
| 14/05/07 | Second Life | Dr Peter Samuels (CU) |
| 04/07/07 | ICMI 17 | Dr Chris Sangwin (Birmingham) |
| 31/10/07 | Maths Support in Australia | Dr Richard Gadsden (LU) |
| 05/12/07 | Next Generation Environments | Dr Peter Samuels (CU) |
| 06/02/08 | WebALT | Sue Milne |
| 13/02/08 | Applying Positive Psychology and the Skills of Well-Being | Dr Nick Bayliss |
| 01/05/08 | Mobile Problem Solving | Richard Seaton |
| 01/05/08 | Mobile Learning | Dr Peter Samuels (CU) |
| 01/05/08 | Learner Engagement | Eric Hamilton |
| 13/05/08 | Numeracy Support | David Bowers (Suffolk College) |
| 04/03/09 | Creativity Laboratory | Dr Peter Samuels (CU) |
| 04/03/09 | Learning Styles | Chetna Patel (Sheffield) |
| 04/03/09 | Assessment Engagement | Dr Trevor Hawkes (CU) |
| 04/03/09 | Measuring Support Effectiveness | Prof Tony Croft (LU) |
| 04/03/09 | Mediating Moderating Effects | Roy Bhakta (CU) |
| 09/12/09 | Knowledge Representation Techniques | Dr Peter Samuels (CU) |
| 24/03/10 | Peer Assisted Study Sessions | Marcia Ody (Manchester) |

Appendix 2: sigma's Objectives

sigma's objectives are to:

- enhance university-wide mathematics and statistics drop-in services offered to all students, including investigation of the potential offered by internet facilities and emerging mobile technologies;
- improve learning by teaching, or providing supplementary support to, identified groups of students in small groups (size 20 - 30), incorporating use of innovative and imaginative delivery mechanisms;
- extend existing specialist support for students with disabilities or specific learning difficulties;
- reduce failure and referral rates on mathematics and statistics modules for non-specialists;
- develop and deliver short courses in statistical methods for research students;
- develop a university-wide statistics consultancy service for postgraduate and final year undergraduate project students;
- continue to develop our links with educational experts from around the world;
- investigate and develop innovative use of technology including the use of PDAs, personal response systems and videoconferencing;
- underpin all developments with an extensive programme of pedagogic research;
- undertake detailed evaluation of CETL activities;
- reward excellence of those staff who deliver CETL objectives;
- report findings from CETL activities;
- disseminate good practice and innovation throughout the two collaborating universities;
- establish a support centre at the University of Leeds and then at two other HEIs;
- provide support to those in any UK HEI already supporting students in drop-in centres
- work with the Higher Education Academy and professional bodies for effective dissemination;
- provide a platform and focus for other initiatives concerned with mathematics and statistics education; and
- secure long term funding by providing a high quality students learning experience, building pedagogical research capacity, and exploiting CETL expertise in developing innovative approaches to teaching and learning.

Appendix 3: Drop-in Centres

Usage figures for the drop-in centres and dedicated resource rooms at LU and CU

| Number of visits | 2004 baseline | 2005/06 | 2006/07 | 2007/08 | 2008/09 |
|------------------|---------------|--------------|--------------|---------------|---------------|
| Loughborough | 4,376 | 3,926 | 4,617 | 6,490 | 8,023 |
| Coventry | 1,901 | 2,889 | 3,549 | 4,342 | 4,570 |
| Total | 6,277 | 6,815 | 8,166 | 10,832 | 12,593 |

LU student visits by department and year (previously under-represented groups)

| Number of visits (by department) | 2005/06 | 2008/09 |
|------------------------------------|---------|---------|
| Business School | 41 | 293 |
| Chemistry | 10 | 80 |
| Computer Science | 13 | 72 |
| Economics | 42 | 516 |
| European and International Studies | 2 | 83 |
| Human Sciences | 16 | 172 |
| Social Sciences | 4 | 30 |

CU student visits by faculty and year

| Number of visits (by Faculty) | 2006/07 | 2008/09 |
|------------------------------------|---------|---------|
| Business and Environmental Science | 212 | 342 |
| Health and Life Science | 78 | 77* |
| Engineering and Computing | 3175 | 3367 |
| Art and Design | 1 | 20 |

* PLUS over 150 students from Nursing and Midwifery attended dedicated numeracy support workshops

Appendix 4: Statistics Support

| Number of appointments | 2004 baseline | 2005/06 (target) | 2006/07 (target) | 2007/08 (target) | 2008/09 (target) |
|------------------------|---------------|------------------|------------------|------------------|------------------|
| Loughborough | 0 | 63 (50) | 136 (60) | 125 (70) | 165 (75) |
| Coventry | 0 | 66 (50) | 98 (60) | 92 (70) | 95 (80) |
| Total | 0 | 129 (100) | 234 (120) | 217 (140) | 260 (155) |

Some feedback from students

"You may remember you helped me with some of the stats on my MA dissertation on work engagement. I've just had my provisional mark of 82% (horrah) and wanted to say a big thank you for the time and advice you gave me, it was much appreciated!"

Part-time Postgraduate student, LU

"I really found the first session useful and liked your informal style of working with us. I find stats quite intimidating so your approach helped a lot to overcome my initial anxieties!"

Member of staff, CU

"I wanted to say how useful I found the stats workshops I have attended. The sessions are informative and well supported with handouts and exercises. It is extremely welcome to attend a session on statistics that is clear and understandable – and that one leaves feeling more confident to use stats in research – so thank you. I will certainly be looking to attend future sessions when I can"

Postgraduate student, CU

"The one-to-one approach was essential as was the non-judgemental attitude of the lecturer who took pains to explain what no doubt would have been ordinarily, an elementary point, with patience and understanding."

PhD Student, LU

"As a PhD student I have a lot of stats to do and after being out of education for a couple of years this was very scary! It's been extremely helpful to have someone to chat through ideas with as this has helped clarify things for me whilst not having to ask my supervisors each time"

PhD Student, LU

Appendix 5: Additional Needs Support

| Number of students supported | 2005/06 | 2006/07 | 2007/08 | 2008/09 |
|-------------------------------------|----------------|----------------|----------------|----------------|
| Loughborough | 60 | 47 | 42 | 64 |

Appendix 6: Proactive Teaching Interventions

| Mode\Year | 2005-6 | 2006-7 | 2007-8 | 2008-9 | Total |
|---------------------------------------|-----------|-----------|-----------|-----------|-----------|
| Alternative provision | 5 | 6 | 0 | 4 | 15 |
| Secondments into sigma | | | | 5 | 5 |
| Supplementary Teaching (at risk) | 2 | 3 | 2 | 4 | 11 |
| Supplementary Teaching (whole cohort) | 5 | 3 | 2 | 5 | 15 |
| Secondments out of sigma | | | 1 | 1 | 2 |
| Enhanced teaching | 3 | 3 | 7 | 9 | 22 |
| Total | 15 | 15 | 12 | 28 | 70 |

Human Sciences intervention

"Just to give you some updates. Last year was the first year that nobody failed HUA405 (as far as anybody can remember this is a first!) so I think that is on its own evidence of the value of the support you provided. In addition I recently received the student feedback questionnaires and there were several that had extremely positive comments about the support you provided."

Dr Paula Griffiths, Senior Lecturer, Department of Human Sciences, LU

Economics intervention

"The experience of the Department of Economics is that this activity has been wholly beneficial. The specific postgraduate course is of immense benefit and is the basis for almost all of the analytical economics taught on the MSc programme. The undergraduate support has been the subject of very favourable feedback ... There is no doubt in my mind that the CETL project and the MLSC activity in general is of major benefit to students of Economics and consequently it is a major support to the Department."

Prof Tom Weyman-Jones, Head of Department of Economics, LU

Disaster Management intervention

"I have just completed marking the 108DST exams scripts and calculated the final module marks ... The results show a remarkable improvement on last year and I believe it is largely down to the maths support the students received in term 1. On this basis I have been talking with my colleagues and, if you agree, I would like to run this support programme again this with the next intake (predicted about 50-60 students)."

Dr Andrew Fox, Senior Lecturer, Department of Geography, Environment & Disaster Management, CU

Mechanical Engineering

"The one-to-one support provided by the Centre is much appreciated by the students who use it. The numbers attending and the fact that many come back regularly testify to the perceived value of the assistance."

Dr Bill Dunn, Principal Lecturer, Mechanical Engineering and Design, CU

Appendix 7: List of all staff engaged with the CETL

| Name | Institution | Job | Notes |
|-----------------------|-------------|---|---|
| Prof Tony Croft | LU | Professor of Mathematics Education | sigma Director |
| Prof Duncan Lawson | CU | Associate Dean | sigma Director |
| Dr Trevor Hawkes | CU | sigma Associate Director | |
| Moira Petrie | LU & CU | sigma Assistant Director | |
| Dr Peter Samuels | CU | Senior Research Fellow | |
| Dr John Goodband | CU | Research Assistant | |
| Dr Richard Gadsden | LU | Senior Lecturer in Statistics | Retired Feb 2010 |
| Dr Karen Smith | CU | Senior Lecturer in Statistics | Left in summer 2008 |
| Alun Owen | CU / LU | Senior Lecturer in Statistics | Joined CU in October 2008. Left to join LU in October 2009. |
| Dr Michail Papathomas | CU | Lecturer in Statistics | Joined in December 2009 |
| Mollie Gilchrist | CU | Lecturer in Statistics | Joined 0.5FTE October 2009 |
| Dr Martin Harrison | LU | Associate Dean (Teaching) | sigma management committee member |
| Dr David Green | LU | sigma Evaluation Officer | |
| Quang Nguyen | LU | Technical Officer | |
| Emily Carey | CU | Technical Officer | |
| Steve Joiner | CU | Administrative Assistant | Joined in January 2009 |
| Kay Khatun | CU | Administrative Assistant | Joined in January 2008. Left in October 2008 |
| Nikki Quinn | CU | Administrative Assistant | Joined in January 2006. Left in October 2007 |
| Serg Sellers | LU | Industrial Placement Student | August 2006 to September 2007 |
| Nick Blenkin | CU | Industrial Placement Student | July 2009 to June 2010 |
| Prof Barbara Jaworski | LU | Professor of Mathematics Education | Post part funded by sigma |
| Clare Wright | LU | Secretary | Post part funded by sigma |
| Julie Armett | LU | Secretary | Post part funded by sigma |
| Zakia Lashari | LU | Secretary | Post part funded by sigma |
| Dr Carol Robinson | CU | Director, Mathematics Education Centre | sigma management committee member |
| Clare Trott | LU | Eureka Centre Co-ordinator | |
| Dr Lara Alcock | LU | Lecturer in Mathematics Education | |
| Dr Rod Bond | LU | Manager, Leicestershire Further Mathematics Support Network | |
| Harry Gordon | LU | Mathematics Support Tutor | Post part funded by sigma |
| Richard Buxton | LU | University Teacher | Post part funded by sigma |
| Dr Matthew Inglis | LU | Lecturer in Mathematics | |
| Dr Mohammad Jaffar | LU | Lecturer in Mathematics | |

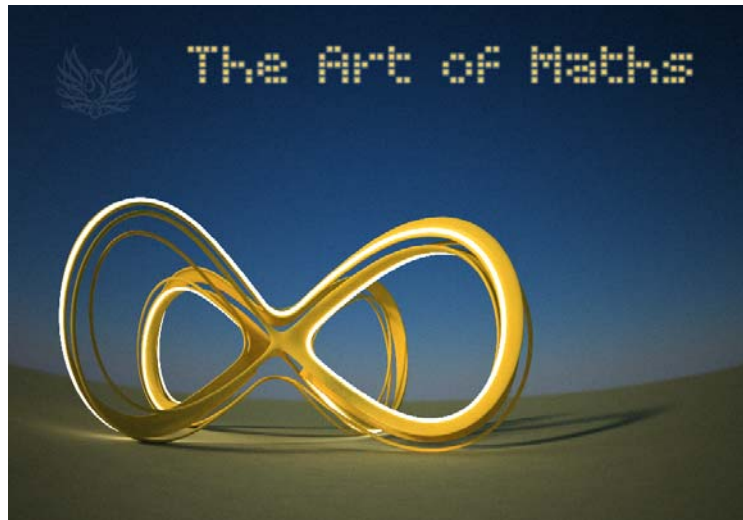
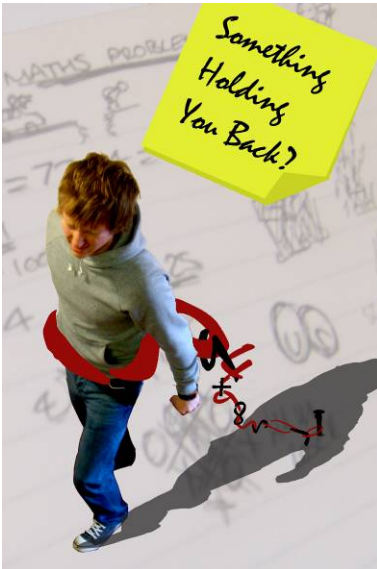
| | | | |
|--------------------|--------------------------|---|----------------------------------|
| Janette Matthews | LU | Mathematics Support Tutor | Post part funded by sigma |
| Dr Aruna Palipana | LU | Learning Technology Manager | |
| Dr Glynis Perkin | LU | Progression Project Officer | |
| David Pidcock | LU | University Teacher | |
| Barbara Rundle | LU | Project Officer | |
| Nicola Timson | LU | Mathematics Support Tutor | Post part funded by sigma |
| Dr Joe Ward | LU | Senior Lecturer in Mathematics | |
| Dr Jim Tabor | CU | Head of Department, Mathematics, Statistics and Engineering Science | |
| Sidney Tyrell | CU | Senior Lecturer in Statistics | |
| Neville Hunt | CU | Assistant Head, Dept of Mathematics | |
| Ria Symonds | LU | PhD student | Funded by sigma |
| Antony Edwards | LU | PhD student | |
| Roy Bhakta | CU | PhD student | Funded by sigma |
| Samuel King | LU | PhD student | |
| Somali Roy | LU | PhD student | Part funded by sigma |
| Stephanie Thomas | LU | PhD student | |
| ChengLiang Hu | CU | PhD student (did not complete) | Funded by sigma |
| Chetna Patel | CU | PhD student (transferred in 2009) | Funded by sigma |
| Marijn Waaijer | LU | PhD student (did not complete) | |
| Daniella Bright | LU | PhD student (did not complete) | Funded by sigma |
| Eligio Cerval Peña | Birmingham University | PhD student (completed an MPhil) | Part funded by sigma |

Appendix 8: CETL-MSOR Conference Information


| Year | Location | Conference Title | No of delegates |
|------|------------------------------------|---|-----------------|
| 2006 | Loughborough University | | 103 |
| 2007 | Birmingham University | | 114 |
| 2008 | Lancaster University | Shaping the Future of Maths & Stats in Higher Education | 121 |
| 2009 | The Open University, Milton Keynes | Opening Windows on Mathematics & Statistics | 130 |

Appendix 9 Examples of work created by students

Postcard designs by CU 1st Year Animation students



Poster designs by LU student ambassadors



WHAT'S THE PROBABILITY HE'S GOING HOME ALONE TONIGHT?

Drop-in statistics support available Monday-Friday

Schofield Building: A0.39
Sir David Davies: W1.42

Monday-Thursday: 10am - 5pm
Friday: 10am - 4pm

Mathematics Learning Support Centre
Open to students from ALL departments
No appointment necessary

Visit <http://mlsc.lboro.ac.uk> for more information

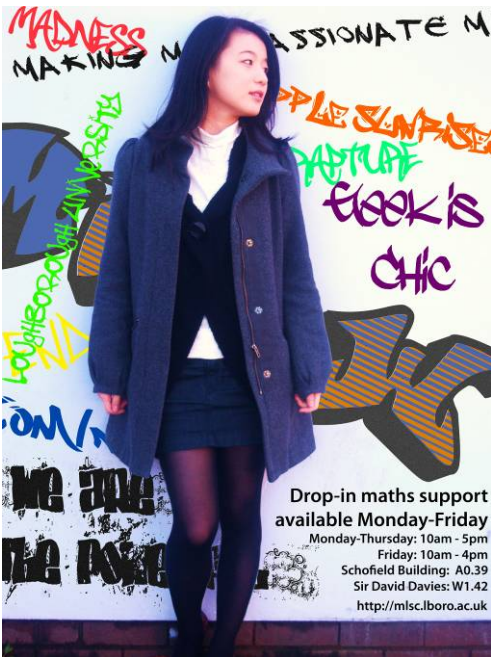


DON'T SUFFER IN SILENCE

Drop in maths support

Monday - Thursday: 10am - 5pm
Friday: 10am - 4pm
Schofield Building: A0.39
Sir David Davies: W1.42

<http://mlsc.lboro.ac.uk>



Drop-in maths support available Monday-Friday

Monday-Thursday: 10am - 5pm
Friday: 10am - 4pm

Schofield Building: A0.39
Sir David Davies: W1.42

<http://mlsc.lboro.ac.uk>



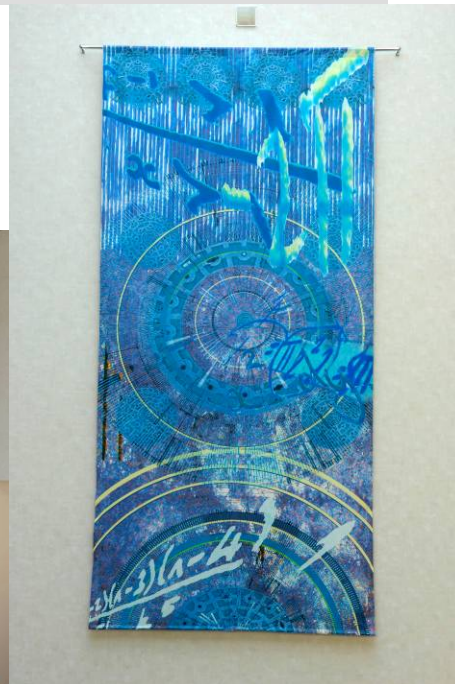
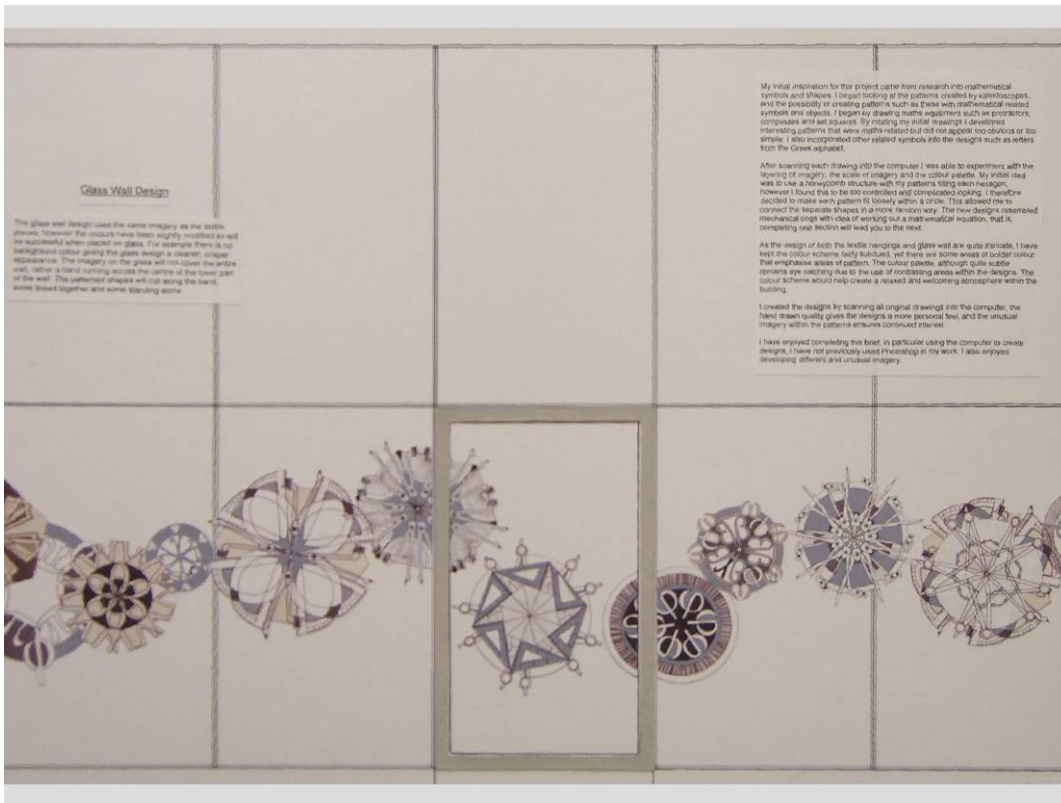
Drop-in maths support available Monday-Friday

Monday-Thursday: 10am - 5pm
Friday: 10am - 4pm

Schofield Building: A0.39
Sir David Davies: W1.42

<http://mlsc.lboro.ac.uk>

Designs by LU 2nd Year Textile Design students



References

- [1] <http://www.qaa.ac.uk/reviews/reports/institutional/Loughborough08/RG378Loughborough.pdf>
- [2] <http://www.qaa.ac.uk/reviews/reports/institutional/Coventry09/RG407Coventry.pdf>
- [3] Symonds, R.E., 2009. Evaluation Student Engagement with Mathematics Support, Thesis PhD, Loughborough University
- [4] Wenger, E. 1998. *Communities of Practice: Learning, Meaning and Identity*. Cambridge: Cambridge University Press.
- [5] Fredricks, J. A., P. C. Blumenfeld and A. H. Paris. 2004. School Engagement: Potential of the Concept, State of the Evidence, *Review of Educational Research* 74(1):59–109.
- [6] Becher, T. 1989. *Academic tribes and territories: Intellectual enquiry into the cultures and disciplines*. Milton Keynes: Open University Press.
- [7] Craig, R. T. (2003) Discursive origins of a communication discipline. in Annual Convention of the National Communication Association, 2003. Miami Beach, Florida.
- [8] McNiff, J. 2002. *Action research for professional development*, 3rd edition, <http://www.jeanmcniff.com/booklet1.html>.
- [9] Draper, S. W., and M. I. Brown. 2004. Increasing interactivity in lectures using an electronic voting system. *Journal of Computer Assisted Learning*, 20(2):81–94.
- [10] Nicol, D., and J. Boyle. 2003. Peer instruction versus class-wide discussion in large classes: A comparison of two interaction methods in the wired classroom. *Studies in Higher Education* 28(4):457–473.
- [11] Brinkman, W.-P., A. Rae, and Y.K. Dwivedi. 2007. Web-based implementation of the Personalised System of Instruction: A case study of teaching mathematics in an online learning environment, *International Journal of Web-based Learning and Teaching Technologies* 2(1):39-69.
- [12] Kinsner, W. and J. J. Pear. 1988. Computer-Aided Personalized System of Instruction for the Virtual Classroom. *Canadian Journal of Educational Communication* 17(1):21-36.
- [13] Keller, F.S. 1968. Goodbye, teacher..., *Journal of Applied Behavioral Analysis* 1(1):79-89.
- [14] Skinner, B. F. 1961. Why we need Teaching Machines. *Harvard Educational Review* 31:377-98.
- [15] Hartley, P. 2007 New technology and the modern university. Next Generation Environments conference, JISC, http://www.jisc.ac.uk/media/documents/events/2007/04/next_gen_keynote.ppt
- [16] Sharples, M., J. Taylor, and G. Vavoula. 2007. A Theory of Learning for the Mobile Age. In R. Andrews and C. Haythornthwaite (eds.) *The Sage Handbook of E-learning Research*. London: Sage: 221-247.
- [17] Engeström, Y. 1987. *Learning by expanding: An activity-theoretical approach to developmental research*. Helsinki: Orienta-Konsultit.
- [18] Lakoff G. and R. Nunez. 2001. *Where Mathematics Comes from: How the Embodied Mind Brings Mathematics into Being*, Basic Books.
- [19] Gollwitzer, P. M. 1999. Implementation Intentions: Strong Effects of Simple Plans. *American Psychologist* 54:493-503.
- [20] Webb, T. L. and P. Sheeran. 2007. How do implementation intentions promote goal attainment? A test of component processes. *Journal of Experimental Psychology* 43:295-302.
- [21] Entwistle, N. 1988. *Styles of Learning and Teaching An Integrated Outline of Educational Psychology For students, teachers and lecturers*, London, David Fulton Publishers Ltd.
- [22] Ramsden, P. 1997. The Context of Learning in Academic Departments, in F. Marten et al. (Eds.) *The Experience of Learning*, Scottish Academic Press, Edinburgh.

[23] Case, J. and D. Marshall. 2004. Between deep and surface: procedural approaches to learning in engineering education contexts, *Studies in Higher Education* 29(5):606-615.

[24] http://www.lboro.ac.uk/admin/policy/strategic_plan.pdf