


Cover Sheet for Proposals (All sections must be completed)			
Name of Capital Programme:		Reuse of learning content	
Name of Lead Institution:		Coventry University	
Name of Proposed Project:		Reuse of learning content for proactive mathematics support in science service teaching	
Name(s) of Project Partner(s):		Loughborough University	
Full Contact Details for Primary Contact:			
Name:	Dr Peter Samuels		
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Length of Project:		1 year	
Project Start Date:		Project End Date: 1 March 2009	
Project Start Date:		1 March 2008	
Total Funding Requested from JISC:		£25,000	
Funding Broken Down over Financial Years (Mar–Apr):			
Mar08 – Apr08		Mar09 – Apr09	
£25,000			
Total Institutional Contributions:		£24,053.72	
Outline Project Description			
To reuse existing external learning resources and produce associated new learning resources to support mathematics learning for science-based subjects; to trial out these resources in sigma's Proactive Teaching Programme; and to investigate making these resources available to the UK HE sector via existing websites associated with sigma.			
I have looked at the example FOI form at Appendix A and included an FOI form in the attached bid (Tick Box)		YES ✓	NO
I have read the Circular and associated Terms and Conditions of Grant at Appendix B (Tick Box)		YES ✓	NO

Reuse of Learning Content for Proactive Mathematics Support in Science Service Teaching

A. Background

1. Many students studying science-based subjects need to take modules involving mathematics as part of their degrees. However, they often lack confidence and motivation and may not have the prerequisite skills required even to begin these modules [1]. Because of this, traditional teaching methods (such as lectures and tutorials) often prove inadequate, especially for the weaker students.
2. Coventry and Loughborough Universities have a proven track record in providing mainly reactive mathematics support to students studying science-based courses. Their experience led to their award of a Centre for Excellence in Teaching and Learning status in 2005 and received funding for five years [2]. Their Centre is called **sigma**. It is based in the Mathematics Support Centre at Coventry University and the Mathematics Education Centre at Loughborough University.
3. As part of its activities, **sigma** instigated a Proactive Teaching Programme at both Universities in both 2005-2006 and 2006-2007 [3]. The aim of this programme is to target “at risk” students on different service mathematics modules and provide them with appropriate proactive support in order to reduce failure rates and hence improve retention. The Programme experienced mixed success and its Steering Committee decided that it should spend the third year mainly developing new resources in order to provide better interventions in the final two years of the **sigma** project.

B. Project Overview

4. **sigma** therefore wishes to develop high quality learning resources for its Proactive Teaching Programme. These will partly be provided by reusing high quality proven learning resources developed by external partner institutions.
5. These materials and their associated teaching and learning methods will be incorporated into **sigma**'s Proactive Teaching Programme with suitable adjustments to both the content and the method of delivery in order to make them more suitable for the target audience.
6. Once these resources have been produced and tested within the Proactive Teaching Programme, it is desired that they will be made available to the UK HE community via the **mathcentre** (www.mathcentre.ac.uk) and **math tutor** (www.math tutor.ac.uk) websites [4] and the HELM (<http://helm.lboro.ac.uk/>) website [5]. All three of these websites are run from the Loughborough University Mathematics Education Centre and are extremely popular with students across the UK and the world.

C. Project Aims and Objectives

7. The aim of the Project is to reuse existing learning resources and produce associated new learning resources to support mathematics learning for science-based subjects, namely:
 - discrete mathematics for first year undergraduate computer science students (**JACS Code G100**);
 - mathematics for foundation year engineering students (**JACS codes G100 and G160**); and
 - mathematics for first year undergraduate engineering students (**JACS codes G100, G121, G130 and G160**)
8. These learning resources will be trialled out within the **sigma** Proactive Teaching Programme then, provided that they pass a quality audit, they will be made available to the wider UK HE community via websites associated with **sigma**.
9. The primary objective of the Project is to reuse and develop new material in discrete mathematics for first year undergraduate computer science students. The learning content we plan to reuse is the self-paced learning discrete mathematics material from Brunel University [6]. These materials have been developed and tested over 25 years and comprise of:
 - self-paced learning notes;

- online tests;
 - summary videos; and
 - solution video clips
10. They have been made available to Coventry University on an informal basis since 2006 for use in their discrete mathematics module. Some work has already taken place to upgrade and extend these materials to cover the Coventry University syllabus but much more is needed. The materials are designed to be used with a teaching method called Computer Assisted Programmed System of Instruction (CAPSI) [6]. This method was trialled at Coventry University in 2006-2007 with a streamed class of “at risk” computer science students. This experience led to some modifications to the method in 2007-2008 in order to fit in better with the Coventry University teaching context [7]. Brunel University is happy to allow **sigma** to reuse its learning content – see attached letter in Appendix 2.
11. The secondary objective of the project is to investigate the reuse and development of other external materials for science-based mathematics teaching, including:
- The reuse of video clips to teach basic engineering mathematics, developed by Newcastle University [5]. Many of these clips are already available via the HELM website but we wish investigate deploying them more directly within an engineering module within our Proactive Teaching Programme (for example, by making them available on a DVD or by linking them to other learning materials).
 - The use of tablet PCs to support calculus teaching as pioneered by the US Air Force Academy [8].
 - The use of classroom communication systems to teach learning “bottlenecks” in first year engineering mathematics as pioneered by the University of Strathclyde [9].

The first two of the project providers is happy to allow **sigma** to reuse their learning content – see attached letters in Appendix 2. **sigma** has a close working relationship with the classroom communication system innovators in the Engineering Faculty at the University of Strathclyde but has not been able to obtain formal permission from them to reuse their learning content in time for the deadline for this proposal. It will be also sought in due course.

12. During the project, the following issues will be considered within each of the work packages:
- **Cultural issues regarding the sharing of content** – we do not anticipate serious cultural issues to emerge for the UK-based materials, except if examples are specific to the institution from which they originated or its culture (such as the choice of names when institutions have differences in the size of their ethnic minority populations). We anticipate that there may potentially be cultural issues related to the reuse of materials from the US Air Force Academy due to differences in syllabus between the UK and America, cultural differences between the UK and America in language and the choice and details of applications of mathematics and contextual differences of the military education environment compared with the civilian educational environment.
 - **Technology issues regarding the creation and sharing of content** – some of these issues have already been addressed as the Brunel discrete mathematics materials were trialled at Coventry University in 2006-2007
 - **The sharing of the project deliverables across the sector** – we are planning to make all materials reused and developed available to the whole UK HE sector via the **mathcentre**, **mathutor** or HELM website, provided that copyright permission is received and the materials pass a quality audit.
 - **Disability implications relating to the repurposed content** – we shall consider these issues as part of the quality audit. The Mathematics Education Centre at Loughborough University has a strong interest in disability needs and has already developed a website which is sensitive to these needs for the Dyslexia and Dyscalculia Interest Group in for supporting mathematics teaching in UK HE (DDIG) – see <http://ddig.lboro.ac.uk/>.

D. Description of the sigma Proactive Teaching Programme

13. The **sigma** Proactive Teaching Programme has run since 2005. The aim of the Programme is to **reduce failure rates** in mathematics service teaching modules and hence improve retention rates. Initially, module leaders in departments requiring service teaching were approached as

part of the original sigma bid [10]. These led to the establishment of 11 interventions in 2005-2006 and 10 interventions in 2006-2007.

14. Of these 21 interventions over the 2 years, 7 were specifically relevant to this Project bid and are described in **Table 1**. All these interventions took place at Coventry University (Level 1 refers to first year undergraduate and Level F refers to foundation year). The applied mechanics interventions were supplementary classes (in 2006-2007 students did not have to attend the classes if they passed an initial diagnostic test – hence the smaller group size). All the other interventions were streamed by a combination of entry qualification, diagnostic test score and self-selection.

Year	Level	Subject	Length	Group Size	Cohort Size	Format	Result
'05-'06	1	Discrete mathematics	24 weeks	25	190	Lectorial	Mixed: try new teaching method
'05-'06	1	Applied mechanics	10 weeks	26	26	School style with regular diagnostic tests	"Remarkable improvement": continue
'05-'06	1	Engineering mathematics	24 weeks	25	97	School style	Positive: continue
'06-'07	1	Discrete mathematics	24 weeks	27	156	CAPSI	Mixed: make the intervention optional
'06-'07	1	Applied mechanics	10 weeks	39	51	School style with regular diagnostic tests	Mixed: problems with pace and perceived relevance
'06-'07	1	Engineering mathematics	24 weeks	24	87	School style	Mixed
'06-'07	F	Engineering mathematics	24 weeks	21	97	Lectorial	Poor: hard to cover syllabus in time provided

Table 1: Engineering and computing interventions in 2005-2006 and 2006-2007

15. The teaching format of the individual interventions varied. Common formats adopted were **school style teaching** which was highly interactive and potentially adaptive, requiring an experienced teacher [11], and lectorials [12] which combined lectures with tutorials, often in a 2 hour session. The school style teaching method was augmented with regular diagnostic tests for the applied mechanics module. This worked very successfully in 2005-2006 but less successfully in 2006-2007, mainly due to staff and department changes and poor communication.
16. As can be seen from **Table 1**, the results of these interventions were mixed. In view of this the Programme Committee decided to cut back on the interventions in the 2007-2008 Academic Year in order to concentrate on developing more resources to be used in the final 2 years of the **sigma** project. Therefore, of these interventions, only the discrete mathematics intervention is running in 2007-2008 as it had performed relatively well in 2006-2007 and had received a lot of resource investment. However, it was decided to make this intervention **supplementary** and **voluntary** in order to increase student motivation and not to disadvantage anyone who may have preferred a more traditional teaching method.

E. Primary Objective: Reuse and Development of the Coventry University Discrete Mathematics Intervention

17. The Coventry University discrete mathematics intervention is already heavily based on reused learning content from Brunel University. However, much more work is still required in order to cover the whole syllabus systematically and with high quality learning content. The current status of the reuse and development of the materials is shown in **Table 2**.
18. The **syllabus** is divided into **6 blocks**. Each block is then divided into 3 or 4 **units**. One unit roughly corresponds to one lecture (there are 21 weeks of lectures followed by 2 weeks of advice on revision for the examination). However, the intervention syllabus covers the initial material on logic in a lot more detail (for example, there are 4 units corresponding to the first lecture). The Brunel syllabus only covered approximately 60% of the Coventry syllabus. The

Brunel module only runs for one semester whereas the Coventry module runs for the whole year.

19. The **self-paced learning notes** cover the syllabus in more detail than the lectures and are written in an open learning style with icons used to indicate related learning resources, such as the module text book and videos – see **Figure 1**. Each unit is between 4 and 10 pages long. The learning objectives for the module are clearly stated at the start and an estimate is provided for the learning time required for students to cover the material.

Block	Unit	Status of material reuse & development		
		Notes	Videos	Online tests
1: Logic I	1: Statements and connectives	Reused	Reused	Reused
	2: Logical equivalence, tautologies and contradictions	Reused	Reused	Reused
	3: Implication	Reused	Reused	Reused
	4: Further logical equivalence and the biconditional	Reused	Reused	Reused
2: Data Structures I	1: Sets – introduction	Reused	Reused	Reused
	2: Sets – further concepts	Reused and developed	Reused	Reused
	3: Relations	Reused	Reused	Reused
	4: Functions	Reused	Reused	Reused
3: Logic II	1: Valid arguments	Reused	Reused	Reused
	2: Compound arguments and fallacies	Reused	Reused	Reused
	3: Quantifiers	Reused	Reused	To be reused
4: Data Structures II	1: Equivalence relations and congruence arithmetic	Developed	To be developed	To be developed
	2: Matrices and Relations	Developed	To be developed	To be developed
	3: Graphs	Developed	To be developed	To be developed
	4: Trees and Coding	Developed	To be developed	To be developed
5: Algorithms	1: Algorithms and their efficiency	Reused and developed	Partially reused, to be developed	To be reused and developed
	2: Algorithms for graphs	Developed	To be developed	To be developed
	3: Searching and sorting algorithms	Developed	To be developed	To be developed
	4: Introduction to cryptography	Developed	To be developed	To be developed
6: Extension Material	1: Arguments involving quantifiers	Reused	Reused	Reused
	2: Sequences and induction	Reused and developed	Reused	Reused
	3: Proof methods	Reused and developed	Partially reused	To be developed
	4: Algorithm correctness and the RSA cipher	Developed	To be developed	To be developed

Table 2: Current status of learning content reuse and development for the Coventry University discrete mathematics module

20. The **videos** are provided in two different types:

- summary videos of individual units (about 8 to 15 minutes long); and
- solution video clips of individual exercises (between 1 and 5 minutes long).

The videos inherited from Brunel University are of a reasonable quality but many will need to be remade in due course in order to meet quality assurance standards (for example, the version of the related text book has changed leading to changes in question numbers and some of the

question details, such as variable names). The videos are delivered at Coventry University via a network drive. They are also given to all students in the intervention group on a DVD free of charge. It is hoped that they will also be streamed internally in the future, but this has proved problematic, especially within the University's Virtual Learning Environment (VLE). **sigma** has a video recording studio and trained staff to assist the project in making new videos.

124MS: Logic and Sets
Block 3: Logic II

whether the conclusion is true in all cases in which both premises are true.
Argument iii) gives us the truth table:

Truth Table for the Argument Form:
 $P \Rightarrow Q, Q, \vdash P$

Premises				Conclusion	
P	Q	$P \Rightarrow Q$	Q	P	P
t	t	t^*	t^*	t	t
t	f	f	f	t	t
f	t	t^*	t^*	f	f
f	f	t^*	f	f	f

In this case the third row has both premises true but the conclusion false. Thus the argument is not valid.

Note: The first row has both premises and conclusion true, but this is irrelevant to the validity of the argument. An argument is valid only if in all cases that the premises are true it follows that the conclusion is also true. An argument like this one in which even if the premises are true, the conclusion may or may not be true is like a leaky bucket, it cannot be relied upon. The essence of logic is of course reliability. In computing this is related to the issue of reliability of software, which is very important, especially for "safety critical" systems such as those controlling aircraft or nuclear power stations.

EXERCISE

- Use a truth table to determine whether the following two argument forms are valid:
 - (Epp Example Set 1.3, question 8) $P \vee Q, P \Rightarrow \neg Q, P \Rightarrow R \vdash R$
 - (Not in the book) $P \Rightarrow Q, P \Rightarrow R, \vdash P \Rightarrow Q \wedge R$
- (Epp Exercise Set. 1.3, question 12) Prove that the following argument (modus tollens) is valid:
 $P \Rightarrow Q, \neg Q \vdash \neg P$

1.3 Modus Ponens and Modus Tollens

The valid argument form:

$$\begin{array}{l} P \Rightarrow Q \\ P \\ \hline \therefore Q \end{array}$$

is called **modus ponens** (Latin for 'method of proving'). It is the most basic **rule of inference** (way of obtaining a conclusion from a list of premises).

The valid argument form:

$$\begin{array}{l} P \Rightarrow Q \\ \neg Q \\ \hline \therefore \neg P \end{array}$$

is called **modus tollens** (Latin for 'method of denying'). Epp (page 32) claims that over 40% of students do not have an intuitive grasp of this. As it is very frequently used in mathematics it is important that you do your best to grasp it. We can show that modus tollens is valid by using a truth table (see Exercise 2 above). It may also be deduced from modus ponens and the law of the contrapositive. For, according to this:

Unit 1: Valid Arguments
Page 3

Figure 1: Example page of discrete mathematics self-paced learning notes

- The **online tests** are delivered via the University's VLE (Blackboard). These were successfully converted from the Brunel VLE (WebCT), although many questions contained extremely complex HTML scripts due to conversion from an external application (such as Word). Questions are given in a variety of formats and feedback is provided both on correct and incorrect responses. Each question is selected at random from a small cluster of similar variants. An example of a question is shown in Figure 2. Student feedback on the online tests has generally been very positive as it allows them to develop a conceptual understanding of the content without potential embarrassment. The tests are selectively released when students achieve a mastery score of 80%. However, as with the other Proactive Interventions, they do not count towards the final module assessment as **sigma** has no control over the module curriculum.
- Other elements of the CAPSI teaching method** include paper-based tests and group coursework based around learning software. It has not been possible to reuse the coursework due to **sigma** having no control over the curriculum for the intervention group at Coventry. The CAPSI paper-based tests are administered to students at their own pace. The purpose of these

tests is formative assessment with feedback via a one-to-one dialogue between the student and an instructor. This has been shown to have a great effect on students' **engagement** with the learning content. However it was found to be problematic to allow students to self-select when they were ready to sit paper-based tests when it was attempted at Coventry, due to their weakness at the subject and their reluctance to engage with the learning materials. This is a common observation of the Programmed System of Instruction from which the CAPSI method is derived [6]. This has been overcome in 2007-2008 by setting paper-based tests for the whole intervention group at once.

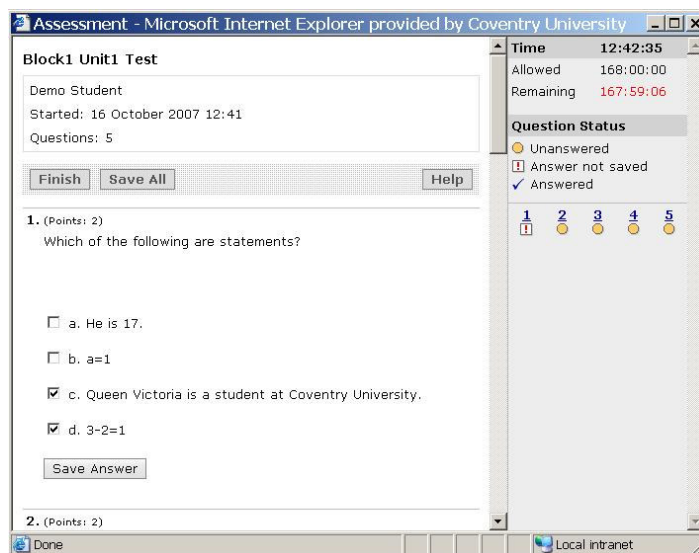


Figure 2: Example of a discrete mathematics online test question

23. **Estimation of reuse and development work** - each unit of the notes has taken on average 6 hours to reuse and 8 hours to develop. Reuse time was high due to changes in notation and the need for a more systematic style. Each online test took approximately 3 hours either to reuse or develop. The advantage of reusing the existing online tests is that it provides a template to work from. It is not possible to estimate the reuse effort required for the videos as most of the time-dependent activities related to the production of the DVD (for example, it took several hours to create a DVD master disk due to technical difficulties). The other main problem with the reuse of the videos is the change in the question numbering between different versions of the related text book. A much simpler naming system has now been adopted. The development of new videos will take approximately 20 person hours per unit. Where videos can be edited and reused this will be significantly shorter. This estimate is based on the Project Lead Investigator's previous experience of developing videos at Brunel University. Based on these estimates, this gives an estimated total reuse and development time of approximately 270 person hours for the discrete mathematics materials (230 hours for the videos and 40 hours for the online tests).
24. **Investigation of the feasibility of releasing materials via an existing website** – once the module has been fully reused and developed and it has been assessed and approved for quality, a feasibility study will be carried out for converting it into a web-based format which can be made available to the entire UK HE community. This may require some modifications to the syllabus to make it more generic (for example, the content could be reduced to that covered by the SEFI Level Zero and Level One Core Curriculum for discrete mathematics [13]). It will also require a feasibility study for converting the online tests from Blackboard format into a non-commercial format.

F. Secondary Project Objective: Investigation of the Reuse and Development of other External Materials for Mathematics Teaching for Science Students

25. In addition to the reuse and development of high quality learning resources to support first year discrete mathematics teaching for computer science students described in Section E above, this Project will also investigate the potential and feasibility of reusing and developing learning content in the style of the other three external sources listed above. These have been chosen due to their apparent success at their own institutions or their existing record for reuse.

26. **The use of classroom voting system to teach engineering mathematics at the University of Strathclyde** – this method has been documented as significantly improving class attendance and also significantly reducing first year drop-out rates [14]. In this reference, the author cites the reason for the success of this method as it being based on particular learning “bottlenecks” in engineering mathematics. The Project will investigate the existence of these bottlenecks and attempt to reuse associated learning content within the Proactive Teaching Programme.
27. **The use of graphics tablets to promote calculus teaching by the US Air Force Academy** – The Project will investigate the feasibility of adopting this teaching method [8] and its associated learning content within its Proactive Teaching Programme in 2008-2009. **sigma** has already invested in a number of tablet PCs, ultra mobile tablet PCs and graphics tablets and wishes to try out their feasibility for teaching mathematics and has been carrying out feasibility research into the use of new technologies in mathematics support [15].
28. **The reuse of mathematics videos produced by Newcastle University** – Newcastle University has already made 85 short video clips on engineering mathematics available to the HELM website (http://helm.lboro.ac.uk/pages/video_lessons.html) via video streaming [5]. It is planning to make approximately another 50. The Project will explore the feasibility of reusing all 135 of these video clips within learning resources for engineering mathematics at both the foundation level and the first year undergraduate level within the Proactive Teaching Programme in 2008-2009.

G. Project Deliverables

29. The primary project deliverable will be the **reused and redeveloped discrete mathematics resources for first year computer science students**. This will take the form of self-paced learning notes, summary videos, individual exercise solution video clips and online tests within Blackboard for each of the 23 units of the Coventry University discrete mathematics syllabus (see **Table 2** above).
30. The secondary project deliverable will be an **evaluation report** on the use of these resources within the Proactive Teaching Programme and an assurance of their quality. This will also include a discussion of cultural issues regarding the sharing of learning content, technology issues regarding the creation and sharing of content and disability implications relating to the repurposed content as described in paragraph 12.
31. The third project deliverable will be a **feasibility report** of the sharing of the primary project deliverable across the UK HE sector, the use of classroom voting system to teach engineering mathematics, the use of graphics tablets to promote calculus teaching and the reuse of mathematics videos produced by the Newcastle University as described in paragraphs 12, 24, 26, 27 and 28 above.
32. **Monthly progress reports** will be produced to inform the Steering Group of progress and any issues that may need consideration.
33. A **final report** will be produced which will summarise all the above deliverables and will provide an account and evaluation of the overall performance of the Project.

H. Project Methodology

34. The project will follow the **JISC project management guidelines** [16] for the development of the project plan, effective communication between the stakeholders and reporting progress to the JISC and the Project Steering Group, which will meet every three months. The project is broken down into individual work packages for more effective management and financial control.
35. The learning materials reused or developed for modules within **sigma**'s Proactive Teaching Programme will go through Coventry University's usual quality assurance procedures prior to their delivery [17]. These procedures are put in place to ensure that students have high quality learning opportunities and that the standard of the award of quality assurance is sound and fit for purpose. Similar procedures will be undertaken if the Proactive Teaching Programme Committee also decides to deploy these materials at Loughborough University.

I. Project Management Arrangements

36. The existing **sigma** Proactive Teaching Programme Committee will be asked to oversee the project. And will act as the Project's **Steering Group**. Currently, its members are:

- Dr. Peter Samuels (Senior Research Fellow, **sigma**)
- Prof. Duncan Lawson (Director, **sigma**)
- Dr. Tony Croft (Director, **sigma**)
- Dr Carol Robinson (Assistant Director, Mathematics Education Centre, Loughborough University)
- Dr David Green (Evaluation Officer, **sigma**)
- Dr Yvette Solomon (Visiting Research Fellow, **sigma**)

We would like to extend this membership to include:

- A representative from JISC
- A representative from Brunel University
- A representative from the Maths, Stats and OR Subject Network (based at the University of Birmingham)

These appointments will be arranged if the bid is successful.

37.



J. Project Timetable

Main Activities	2008										2009			
	M	A	M	J	J	A	S	O	N	D	J	F	M	A
WP1 Project management														
Set up project	✓													
Set Steering Group meetings	✓			✓			✓			✓			✓	
Progress reporting		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
WP2: Module Development														
Module design, including content repurposing	✓	✓	✓											
New content development	✓	✓	✓	✓	✓									
Assessment strategy and framework					✓									
Obtain learning content from external sources	✓	✓												
WP3: Quality Assurance														
Prepare module descriptor(s)						✓								
Peer review by Faculty Board of Studies						✓								
WP4: Course Delivery														
Deliver module(s)								✓	✓	✓	✓			
WP5: Evaluation														
Evaluate feasibility of other external content			✓	✓	✓									
Evaluate discrete mathematics intervention												✓	✓	
Evaluate feasibility of dissemination of materials to UK HE community													✓	
Write evaluation reports					✓								✓	✓
WP6: Dissemination														
Update sigma website with progress reports		✓			✓			✓			✓			✓
Give presentations and workshops														✓
Write final report														✓
Upload materials to external websites														✓

K. Risk Analysis

Risk	Impact	Probability	Risk Strategy	Actions
Staff loss	High	Low	Reduction	Use current staff. Employ external consultants who can be replaced if required
Failure to meet the needs of stakeholders	High	Medium	Reduction	Strong involvement of stakeholders in project Steering Group. Evaluate this aspect from the beginning of the project. Ensure user involvement in project management.
Lack of student interest	High	Low	Reduction	Ensure students are aware of the innovative nature of the course
Inadequate technology	Medium	Low	Prevention	Deploy tried and tested technologies

L. IPR

38. The IPR for the project deliverables will reside with **sigma**. Therefore both Loughborough University and Coventry University hold equal rights to all the additional resources delivered by the project. A separate agreement will be produced between Loughborough University and Coventry University at the start of the project confirming the arrangement.

M. Sustainability Issues

39. This project will seek to help **sigma** to continuously strive to improve the way that it provides Mathematics support. It is anticipated that any change will form part of an incremental evolutionary approach. Consequently, the deliverables of the project will be retained and maintained by **sigma** as part of its commitment to develop and disseminate good practice in terms of Mathematics support.

N. Dissemination

40. The deliverables from the project will be disseminated to the stakeholders through the following channels:
- The deliverables of the project will be made available through the **sigma** (and associated websites) and JISC;
 - A case study will be produced outlining the process and issues encountered in the development of this module;
 - Additional awareness and promotional materials will be circulated by **sigma** through the MSOR network
 - Findings will be presented at conferences and through journals

O. Evaluation

41. We will work with the evaluation strategy and structures currently in place in **sigma** to ensure that this project is evaluated properly. This includes evaluation of performance and experience of students in the identified group, through examination of exam results, interview and focus groups with students. The **sigma** Evaluation Officer will assist in this process. We will also be available to participate in any JISC evaluation feedback after the funded period.

P. Potential Benefits to the JISC Community

42. We believe that building on the work of **sigma** within this project will bring the following benefits:
- the creation of reusable learning materials in the area of discrete mathematics;
 - the provision of evidence relating to the sharing and repurposing of materials from an external source; and
 - the feasibility of reusing other forms of mathematics learning content for science students

Q. Budget Summary

43. The budget and justification are based on full economic costs. The budget is broken down as follows:

Directly Incurred Staff	March 2008 – April 2009	
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]
Non-Staff		
Travel	£500.00	
Total Directly Incurred Non-Staff (B)	£500.00	
Directly Incurred Total (A+B=C)		
	£12,845.58	
Directly Allocated		
[REDACTED]	[REDACTED]	[REDACTED]
Estates	£6,864.60	
Directly Allocated Total (D)	£10,787.34	
Indirect Costs (E)		
	£25,420.80	
Total Project Cost (C+D+E)		
	£49,053.72	
Amount Requested from JISC	£25,000.00	
Institutional Contributions	£24,053.72	
Percentage Contributions over the life of the project		
	JISC	sigma
	51%	49%

Appendix 1: Previous Experience of the Team

Dr. Peter Charles Samuels (MA, PhD), SIGMA, Coventry University, UK.

Dr Samuels is Senior Research Fellow in SIGMA. His research is centred on the pedagogical aspects of Mathematics and statistics support and innovative approaches to support, especially the use of new technologies. He is also coordinator of Coventry University's Serious Games Applied Research Group.

Dr Samuels has 15 years' experience in courseware development, especially in the use of technology in mathematics education. For 2 years he developed self-paced learning materials in discrete mathematics for computer science students at Brunel University, comprising of text and video. He has a background in educational research in advanced Mathematics and has helped to pioneer initiatives in the UK in areas such as: university Mathematics support, and computer-aided assessment in Mathematics. He also has industrial experience in management and applied cognitive science, including psychometric assessment. He has a Ph.D. in Mathematics on: "*An account of research into an area of analytical fluid mechanics*" and BA (Hons.) Mathematics (Class I). For four years previous to his appointment at Coventry University, he was an IT Lecturer and Branch Manager, at Vision College, in Birmingham and Reading.

Appendix 2: Supporting Letters

Letter from Vice Chancellor, Coventry University

Coventry University
Priory Street
Coventry CV1 5FB
Telephone 024 7688 7688



JISC Executive
Northavon House
Coldharbour Lane
Bristol
BS16 1QD

30th November 2007

Dear Executive Members

JISC Capital Programme: Re-use of learning content

Project: Reuse of learning content for proactive mathematics support in science service teaching

I have pleasure in providing a letter of support for Coventry University's proposal for the development of this project which will transform the teaching of mathematics for weaker science students.

Coventry University fully supports this proposal led by **sigma**. Further, this proposal supports the aims of Coventry University which seek to provide high quality support for student learning and foster innovation, creativity and enterprise among our students, staff and partner organisations.

Yours faithfully,



Professor Madeleine Atkins
Vice Chancellor

Business Development Support Office
Direct Line 024 7688 8003/7799
Fax 024 7679 5856
www.coventry.ac.uk

Letter from sigma Director, Loughborough University**Mathematics Education Centre**

Loughborough University, Leicestershire LE11 3TU, UK
Switchboard: +44 (0)1509 263171 Centre: +44 (0)1509 228250
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JISC Executive
Northavon House
Coldharbour Lane
Bristol
BS16 1QD

30th November 2007

To Whom It May Concern

JISC Capital Programme: Re-use of learning content

Project: Reuse of learning content for proactive mathematics support in science service teaching

As Director of the sigma Centre for Excellence in Mathematics and Statistics Support at Loughborough University, I fully support the proposed project reusing learning content for the proactive mathematics support in science service teaching.

Should the bid be successful, it will provide vital support for students struggling with the mathematics components of their course. As a result, this will help sigma work towards its goal of developing innovative approaches that address the widely differing curricula and individual needs of different students. In addition, the Higher Education community as a whole will benefit from free and improved access to the repurposed materials.

Yours faithfully,

A handwritten signature in black ink, appearing to read 'A. Croft'.

Professor Tony Croft
Director, sigma and Mathematics Education Centre
Loughborough University

Email from Discrete Mathematics Module Leader, Brunel University

Re: JISC Bid	Page 1 of 1
From: Martin Shepperd [Martin.Shepperd@brunel.ac.uk] Sent: 30 November 2007 10:02 To: Peter Samuels Subject: Re: JISC Bid Dear Peter,	
re: JISC Capital Programme, Circular 4/07, Reuse of Learning Content	
I am very happy for you to reuse the Brunel University Discrete Maths materials including slides etc from myself.	
I wish you every success with the bid.	
best wishes Martin	
***** Professor Martin Shepperd, School of IS, Computing & Maths, Room SJ048 Brunel University, Uxbridge, UB8 3PH, United Kingdom	
tel: +44 (0) 1895 267188 fax: +44 (0) 1895 251686 email: martin.shepperd@brunel.ac.uk url: http://people.brunel.ac.uk/~csstms/	
file://C:\Documents and Settings\aa0489\My Documents\Research\Projects\JISC RLO\Bru... 30/11/2007	

**Letter from the Director of the Center for Research on Learning and Teaching,
US Air Force Academy**

DEPARTMENT OF THE AIR FORCE
THE DIRECTORATE OF EDUCATION
USAF ACADEMY, COLORADO

27 November 2007

Re: JISC Capital Programme, Circular 4/07, Reuse of Learning Content

Dr. Peter C. Samuels
Senior Research Fellow
SIGMA Centre for Excellence in Mathematics and Statistics Support
Faculty of Engineering and Computing
Coventry University, Priory Street, COVENTRY, CV1 5FB

Dear Dr. Samuels,

I so appreciated the chance to speak with you in the Spring at Edge Hill University about work we are pursuing in TabletPC computing as it relates to teaching calculus. Our research is continuing and involves further development, but so far we have shown that the combination of tablet computers with collaborative workspaces is producing statistically significant higher levels of mathematical engagement. Several papers have come out on this and others are in the pipe. We have been using personal digital assistants in a form of experience-sampling-method to measure engagement. One of our next steps is to test, when it is available, the approach with a system that combines digital libraries and artificial agents. For both that work and the work we have completed, we would be honored to share with you anything and everything we have created.

As much as curriculum materials, our work has focused on how teachers on a day-to-day basis use tablet computers before, during and after class sessions, i.e., the human factors pedagogy of tablets with collaborative workspaces in challenging and advanced mathematics classrooms. We use the SynchronEyes commercial system for the collaborative features of our system – in fact, I had patented such a system in the US and UK several years ago, but feel that SynchronEyes is a strong and stable system. SynchronEyes is made by the SmartBoard display maker. I have worked closely with them and they have given us a free research license. Whether or not you use SynchronEyes, we are happy to share with you our materials and the software we use for measuring student engagement. We would be very excited to have an ongoing relationship with you. I am moving much but not all of the research to Pepperdine University when I take an Associate Dean slot there in the Spring, but the Air Force Academy will continue to partner with us in this important work. Tablet computing is opening up some highly unexpected and powerful new avenues for teaching mathematics. It is very exciting to see others in this work. Please keep me posted (eric.hamilton@usafa.edu).

Sincerely,

Handwritten signature of Eric R. Hamilton in black ink.

Eric R. Hamilton, Ph.D.
Research Professor and
Director, Center for Research on Learning and Teaching
US Air Force Academy, CO 80840-6200

Letter from Head of School of Mathematics and Statistics, Newcastle University



**School of
Mathematics & Statistics**
Newcastle University
Newcastle upon Tyne
NE1 7RU UK
Professor G Robertson
Head of School

29/11/07

JISC CAPITAL PROGRAMME
CIRCULAR 4/07, REUSE OF LEARNING CONSENT

The School of Mathematics and Statistics at Newcastle University supports the above bid, and is happy for the videos produced at Newcastle to be reused in teaching at Coventry and Loughborough Universities.

Guyon Robertson

tel: 0191 2226000
fax: 0191 2228020
www.mas.ncl.ac.uk/math/

The University of Newcastle upon Tyne trading as Newcastle University



THE QUEEN'S
ANNIVERSARY PRIZES
FOR MERIT AND FOREMOST ACHIEVEMENT

2005

Appendix 3: FOI Withheld Information Form

We would like JISC to consider withholding the following sections or paragraphs from disclosure, should the contents of this proposal be requested under the Freedom of Information Act, or if we are successful in our bid for funding and our project proposal is made available on JISC's website.

We acknowledge that the FOI Withheld Information Form is of indicative value only and that JISC may nevertheless be obliged to disclose this information in accordance with the requirements of the Act. We acknowledge that the final decision on disclosure rests with JISC.

Section / Paragraph No.	Relevant exemption from disclosure under FOI	Justification
21. Budget Summary	Commercial Interests	Commercial in confidence, budget information refers directly to individual salaries

Please see <http://www.ico.gov.uk> for further information on the Freedom of Information Act and the exemptions to disclosure it contains.

Appendix 4: References

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