

Cover Sheet for Proposals (All sections must be completed)	JISC Capital Programme
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Name of Capital Programme: e-Learning
(e-Learning; e-Infrastructure; Repositories and Preservation)

Name of Lead Institution: Aston University

Name of Proposed Project: AMORA

**Name of Project Partners: University of Central England
Matthew Boulton College**

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Length of Project: 24 months

Project Start and End Dates: September 2006 to September 2008

Total Funding Requested from JISC:
£99912.45

Funding Broken Down over Project Years:
Year 1: £89205.78
Year 2: £10706.67

Total Institutional Contributions:
If JISC pay 80 % of FEC the total they pay is £79929.97
Aston will pay: £19981.48

Outline Project Description
To develop a tool to support the teaching of applied mathematics for healthcare professionals, the tool will be called Applied Mathematics Online Reinforcement and Assessment, AMORA.

The project will develop a system that will allow health care teachers to create mathematical question prototypes simply and generate question sets. These will be assessed formatively to identify the key areas where the student's knowledge fails. The assessment will be based on the JISC work already done in the Serving Mathematics project.

I have read the Circular and associated Terms and Conditions of Grant at Appendix B (Tick Box)	x YES	NO
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E-learning tool to measure mathematical competence in healthcare; assessment to disseminate conceptual and processing errors.

Aim of the study:

To develop a tool to support the teaching of applied mathematics for healthcare professionals, the tool will be called Applied Mathematics Online Reinforcement and Assessment, AMORA.

This proposal outlines an e-learning tool that fits within the JISC serving maths programme. The tool will address the diverse nature of healthcare students and support their mathematical learning to develop confidence necessary for clinical practice. The tool will be used across institutions and will be built using existing JISC e-learning tools.

This project describes the design and piloting of an e-learning tool that uses a constructivist technique to demonstrate mathematical skills and procedures applicable for nurses, pharmacy technicians and pharmacy students that would enable these individuals to develop confidence and ability at their own pace either within the course or via distance learning to improve these skills. The assessment aspect within the tool will disseminate conceptual and processing errors within mathematical procedures to best feedback to learners to support their studies. It is envisaged that this bid will develop and trial the tool for current students and if successful the final package will be available to wider student and professional bodies within healthcare. The project will develop a system that will allow health care teachers to create mathematical question prototypes simply and generate question sets. These will be assessed formatively to identify the key areas where the student's knowledge fails. The assessment will be based on the JISC work already done in the Serving Mathematics project.

The project will also extend JISC projects on the use of LAMS, Moodle or Bodington as appropriate. As these are license free this will enable this project to provide mathematical support for widening participation with FEIs and other HEIs and support for CPD for staff working in the NHS and other health care institutions.

Introduction:

There has been widespread, recent media interest in the decline in mathematical competence within the UK with the Moser report (1999) suggesting that as many as 40% of the adult UK population have some numeracy problems.

Concentration calculations, those involving expression of concentrations in a variety of ways has been identified as a weakness amongst pharmacy students, nursing students and doctors (Batchelor 2004, Lesar et al 1997; Rolfe et al 1995; Kapborg 1994; Hutton 1998; Weeks et al 2000; Kelly and Glaspole 2006).

The traditional method to teach calculations is formula-driven; that is, an example is presented with a formula that describes how the calculation was performed. This is widely used in Pharmacy with many books devoted to such methods (for example, "Introduction to Pharmaceutical Calculations" by Rees et al, 2001), similarly for nurses (eg "Nursing Calculations" by Gatford and Phillips). Students are then able to practise using the given formula hoping to develop competence. Many students can perform well if the calculation is presented in the same way as the original example yet find the explanation or any deviation from this standard far more difficult. Typically the problem is divided into simple steps that are worked through using "mimetic activity" to demonstrate to students what is required. However, this traditional approach may not be consistent with students' information processing styles which, in turn, can hamper their learning (Gredler 2001). Instead of gaining a deep conceptual understanding students are likely to merely imitate the procedures to acquire the desired results.

Mathematical barriers:

There has been much research into why there is widespread anxiety about individuals' mathematical competence (eg Fulton and O'Neill). There are some individuals who have never had a problem with mathematics and are unaffected by anxiety, however, there are many individuals, particularly in healthcare, where they must overcome a mathematical barrier to develop competence for clinical practice. Healthcare professions draw a broad base of students and the diversity of age, gender and ethnicity of students embarking on such careers leads to the diversity in mathematical ability observed within teaching groups. In addition, many individuals have mathematical barriers, in that they have little self-confidence in their mathematical ability and see

this perceived weakness as a block for certain career paths. Research into adults' maths life histories has identified the following themes (Coben and Thumpston, 1996)

- The "brick wall" – the point (usually in childhood) at which maths stopped making sense; this may relate to a particular problem eg long division.
- The "significant other" – this is a person who had a major influence on maths history, perhaps a teacher, parent or sibling who undermined confidence, made the person feel stupid.
- The "door" this may be locked, some people avoid unlocking this door by avoiding any pathway that requires mathematical skills that they don't currently have
- "Invisible maths" – this is the maths that someone can do but doesn't think of as maths but as common sense

These barriers are common to many individuals and it is important to address these in teaching mathematics, particularly in groups where individuals have been out of the education system for some time, this is particularly evident in healthcare professions with a large number of mature students. The concept of supporting individual learning needs and styles is well documented within the wider literature relating to maths learning. The need to diagnose learning needs is recognised as an essential pre-requisite to success in maths ability.

All mathematics can be broken down into two components; computations and problem solving. Computations are the addition, subtraction, multiplication, the tools required to perform maths. In the context of concentration conversions only addition, subtraction multiplication and division are required. These skills are known by a large majority of people entering the healthcare profession. The second component of mathematics is problem solving; understanding the logic of a problem and translating this into the mathematical code to solve the problem. It is this second component that the majority of individuals struggle with.

A constructivist learning environment is defined as a place where learners may work together and support each other as they use variety of tools and information resources in their guided pursuit of learning goals and problem-solving activities (Wilson, 1996).

Constructivist methods have been used in nursing education to aid conceptual understanding of medical calculations (Kelly and Colby 2003). Weeks et al (2000) used a constructivist approach to teaching medication dosage calculations to nurses; he found that the constructivist approach provided a better framework for mathematical learning. Wheeler et al (2006) used an online tool to aid doctors' learning about drug dosages that included images in the question set; this proved successful although interestingly not all students chose to participate.

Situated learning is similar to constructivism, as it is a holistic approach to learning. This technique suggested by Schoenfeld (1994) used situated learning to learn maths in context; learning to think mathematically means developing a mathematical point of view and the tools of the trade in order to make mathematical sense of the world. This uses examples from real world settings to develop deeper understanding of mathematical procedures so that the maths becomes invisible and the processing is common sense.

This project combines constructivism and situated learning and aims to take specific calculation based problems relevant to pharmacy students, pharmacy technicians and nursing students and to use a clinical setting to highlight the need for this knowledge to promote mathematical competence. By relating the practice into the mathematics the learner can visualise the problem and also the procedure which should reinforce the processing required to solve this type of problem. Problems will be shown in both standard formats of words with mathematical formulae used to solve these as well as images that use logic to develop the processes needed to solve the problems. This mix of techniques enables the student to think through the problem using their own logic and to determine the strategy needed to solve the problem, the constructivist theory challenges the student to consider which method best suits their own processing style so that they can reflect upon this and use this technique to solve future problems.

Within this tool students are encouraged to develop their thought processes and move from simple to more complex outcomes; a good understanding is crucial for building students mathematical understanding, confidence and success.

In developing mathematical skills, as with any other skill, there is a need for a positive mind set. Ernest, (1997) described the concept of positive and negative learning cycles in relation to the learning of mathematics. He suggested that if individuals have a negative learning cycle they are

less open to learning new concepts and less willing to recognise their existing knowledge. When considering the emphasis on widening participation to both higher and further education many students may already have experienced a negative maths learning cycle, thus there is a great need to address this.

The e-learning interface for this tool provides a medium where the pace is dictated by the student. This is a form of open-learning where the student can work alone or with a colleague and at a location of their choice to suit their individual learning needs, thus creating a positive learning cycle. It is anticipated that this tool will not be used as a stand-alone teaching strategy but be integrated into the course via lectures, workshops and practical classes, in addition at Aston University there is a maths support centre where any student can get one-to-one tuition on maths, this centre operates as a drop in centre and is open for standard office hours throughout term time.

Formative assessment will be integrated into the programme to allow students to monitor their progress and to move through the topics at their own pace or to revisit topics where they feel they need to refresh their memory.

Scenarios:

The user with a mathematical barrier:

I have never understood what maths is all about, when someone goes through a problem it looks easy but when I try it all goes wrong. I just can't work out which number goes where and as soon as it involves fractions I am lost. It seems to make sense to everybody else but I just don't get it. Most lessons just feel like they are number crunching and I don't understand the formulae they have no relevance. After using the AMORA tool I understood the way that maths should be used, by showing the animations I can see which formula to use.

The individualised learning experience:

Sometime in the lesson I can do all the problems so I drift off but then find we have moved on and now I am lost, I wish I could go at my own pace and concentrate on the parts that I find difficult rather than everything all at once. Also sometimes we have this lesson in the afternoons and I can't concentrate as well then, I would prefer to do this in the mornings. Having access to AMORA I can use this whenever I want and revise subjects in bite sized chunks, I hope to have access to this throughout my career.

Supporting widening participation:

I never thought I could do maths well enough to move on from my current position as a pharmacy technician; this tool has really helped build my confidence and I now feel confident enough to go on to do the foundation degree and maybe even more after that! The AMORA tool taught me maths in a different way from school and I feel that I can really do it and am confident, I just visualise in my head what is happening and know how to do the maths.

Supporting life-long learning:

Since CPD was introduced I have tried to find material that I can use to help in my learning that is relevant to my work (pharmacy technician); this e-tool provided me with an individual learning experience that is really relevant to my job. I can use this tool at times that suit me and do as much or as little as I want in any session. The assessment part allows me to monitor my progress and demonstrates that I am learning.

Project Description

The e-learning tool:

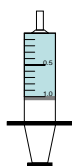
The tool will be a web-based interface with tutorials that demonstrate mathematical operations relevant to healthcare professionals using images and video clips to enhance conceptual understanding of procedures.

Tutorials based on a similar design to PCCAL packages developed by JISC will be written to include images and videos with options to interact in a true/false manner (or multiple choice etc) or to follow a procedure to conceptualise a problem. The problems will be written into a programme (Assessment Tools in Mathematics, at Imperial College will be approached to see how this assessment may be integrated into their programme and to expand on this JISC funded project) that allows alteration of certain parameters to develop a question bank of similar problems. The programme must be developed to allow simple alterations to be made by a non-IT specialist. Each

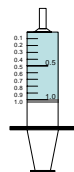
problem may require a unique set of programming to allow manipulation of images to reflect the procedure. For example:

A patient is to be given 10000 units of Caciparine. Available ampoules contain 25000 units in 1 mL. What volume should be dispensed?

To accompany this there should be a visual aid



- 1 mL contains 25000 units
- I need 10000 units, therefore I need less than 1 mL
- I need a fraction of 1 mL
- The fraction is $\frac{10000}{25000}$
- I need 0.4 mL



- Each small graduation on the syringe is equal to 0.1 mL
- Need to deliver 0.4 mL
- Need to use 4 graduations
- If the start reading is 1 mL the final reading will be 0.6 mL

The programme should be written to allow the syringe-image to draw up an excess of material and then to dispense the correct amount dependant upon the calculation; thus variables will be in the amount to be given, the stock concentration and the volume drawn up and dispensed.

Alternative problems could show a volume dispensed and the operator is asked to calculate how many units were present within the volume.

This programme will allow an individualised question set with unlimited alternatives for practice. The process of drawing up and dispensing the liquid will trigger thoughts as to how much is required and the significance of these calculations for the future career.

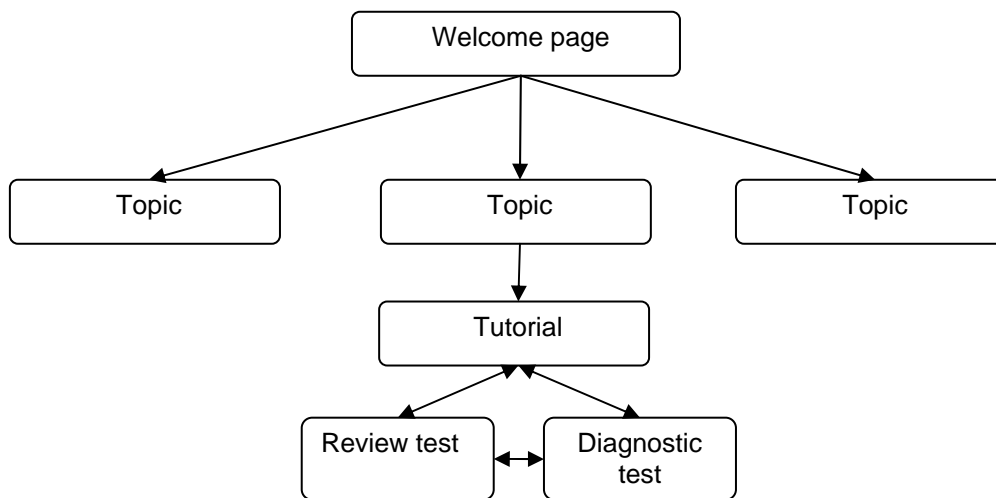
The interactive tool will progress through a series of logical steps to conceptualise the problem, the assessment will ask students to show their own interpretation of the problem and then their mathematical solution to evaluate both processing and computational knowledge. Existing packages test both processing and computations simultaneously, via a simple calculation with a right/wrong answer, thus feedback can be oversimplified. This project will develop a unique style of assessment broken down into stages to allow the point at which an error is made to be determined thus specific feedback can be provided. This feedback can be designed to show the student what the error is and can feed back into the tutorial to revisit a specific area to aid in the overall process.

The method of writing assessments to allow both concepts and computation to be measured is complex, and requires considerable thought. This will be discussed and developed via the key personnel within the team in conjunction with the IT programmer to ensure that the programme reflects the needs of the learner. The programming needs to be able to support many types of information input in terms of words, numerical answers and estimations and appropriate feedback must be available for each stage.

Once developed, this programme will be made available via an interface such as Moodle for open access to all HE and FE institutions as well as healthcare professional bodies.

The Web interface will consist of a welcome page with links to the various topic pages, as decided by the key personnel; example topics will include: converting metric units; converting percentages to mass by weight; and more applied topics including drug dosages for injection; and body surface area calculations. Within each topic there will be a tutorial, based on PCCAL tutorials with introductions and learning outcomes as well as interactive material to conceptualise and explain a procedure and linked to video clips of clinical practice; following this there will be a diagnostic test that uses the visual links to step through the procedure and measures both conceptual and computational understanding. The diagnostic test will be made up of a series of questions that can be dictated by the user based on material within the tutorial; they can design the number of questions and the subject for the questions from the question bank to test specific areas so that the learning can be user lead and divided into sections at the pace dictated by the user; thus providing an individual learning experience. This diagnostic test can be used at any stage for formative assessment. A second assessment tool within each topic will be a review test; this will consist of a set number of questions covering all the material within the tutorial, this will also be used as formative assessment but each attempt by the user will be saved with the date and score so that

the user can monitor progress over time to monitor their own progression and development. The review test will be a words only question bank to mimic more standard questions seen in the large numbers of text books and also to better reflect questions on examination papers; this will then require student to use their logic to both conceptualise and compute an answer within a more standard format.



Schematic of presentation within the Web interface.

Programming requirements:

Basic animations, a mix of computer animations, still images, flash animations and videos to be incorporated into a web interface with interactive motion. PCCAL packages, which are written in authorware and currently in use, demonstrate some of these functions, the incorporation of animations and videos is an addition. The system will make considerable use of web services and user and administrative interfaces will be web driven. The project team would like to use AJAX technology to enhance interactivity. The interface must allow minor changes and adaptation of question banks by non-specialist IT workers.

A key part of the design will be the development of reusable components that can be easily assembled into courses at the appropriate level. The intention is to use the system alongside normal VLE features such as bulletin boards and teaching material.

The server will be hosted at Aston with a WAI compliant interface to ensure access from both UCE and Matthew Boulton College and which will support the open network requirement by JISC for future users. It is hoped that the system can be extended to NHS and other institutions needing mathematics support.

Some problems will involve geometric programming that can be generalised according to the question design. For example the filling of a syringe can be created as a three dimensional animation whereby the start and stop position vary depending on the question and the image reflects this change.

The intention is to base user authentication on Shibboleth if appropriate JISC e-tools are available and create a database of student progress. This database will be used to identify students with particular problems and issues in the teaching of mathematics to this student body.

Budget:

		Year 1	Year 2
DIRECTLY INCURRED COSTS	Staff	27027.10	0.00
	Travel & subsistence	2400.00	0.00
	Other costs	8400.00	6400.00
	Equipment	3500.00	0.00

	Sub-total	41327.10	6400.00
DIRECTLY ALLOCATED COSTS	Investigators' costs	1723.88	1723.88
	Other staff costs	1002.59	1002.58
	Estates costs - generic	6397.91	223.91
	Sub-total	9124.38	2950.37
INDIRECT COSTS	Indirect costs	38754.30	1356.30
	Sub-total	38754.30	1356.30
	TOTAL	89205.78	10706.67

Key Personnel:

Dr Hannah Batchelor, Lecturer in Pharmaceutics, Aston University,
Role: Co-ordinator

Dr Batchelor was appointed lecturer in Pharmaceutics at Aston University in September 2000, since that time she has lead the development of a new first year module on pharmaceutical calculations. She has introduced diagnostic testing and constructivist environments into this course and measured their success and has published these findings. She is gained membership to the Higher Education Academy in 2002.

H K Batchelor, (2004), The importance of a mathematics diagnostic test for incoming pharmacy undergraduates. *Pharmacy Education*. 4(2):69-74

H K Batchelor, (2004), Diagnostic test for pharmacy students as a successful learning and teaching tool. *MSOR Connections Vol 4 No 4*.

<http://mathstore.ac.uk/newsletter/nov2004/pdf/diagnostictest.pdf>

Batchelor, H K (2006) A constructivist method for teaching concentration calculations to pharmacy students. *Submitted to Pharmacy Education*

Dr Julian Smith, Course Director Foundation Degree in Pharmaceutical Technology, Aston University

Role: Consultant

Dr Smith was appointed as a lecturer in Pharmaceutical Sciences in Feb 2004 at Aston University. He is also Managing Director of Viridian Pharma Ltd. since October 2002. Prior to this he has worked as a hospital pharmacist for 20 years and is a registered pharmacist with The Royal Pharmaceutical Society of Great Britain. He is the director of the foundation degree and co-ordinates cross institutional learning on this course between Matthew Boulton College and Aston University.

Mrs Karen Socci, Lecturer/Assessor in Pharmacy Services, Matthew Boulton College

Role: Consultant

Mrs Karen Socci joined Matthew Boulton College of FE & HE in December 2004 as a Lecturer/Assessor in Pharmacy Services. Prior to this appointment Karen was working as a Pharmacy Technician within the NHS. She has held various posts within the hospital Trusts of the West Midlands. During her last post Karen was working as a Chief Technician managing the Aseptic Services Unit at Birmingham Heartlands Hospital.

Karen is a registered member of The Royal Pharmaceutical Society of Great Britain.

During her short time at Matthew Boulton, Karen has been teaching and assessing pharmacy technicians undertaking the BTEC National Certificate in Pharmacy Services. Karen is also the Co-ordinator of the first and second years of the Foundation Degree in Pharmaceutical Technology, and has a role as module co-ordinator of a third year module of the same foundation degree at Aston University.

Maria Kisiel, Senior Lecturer, Adult Critical Care, Department of Health Care Professionals, Faculty of Health, University of Central England in Birmingham

Role: Consultant

Maria was involved in the development of Ware-2-Care, a CD ROM that simulates medication administration, providing a unique opportunity for nurses to develop and consolidate their competency in this essential skill.

Computer Simulation of Medication Administration for Nurses (November 2002);

<http://galeb.etf.bg.ac.yu/~vm/cd1/papers/222.pdf>

Mr John Williams, Server Manager, Aston University

Role: Consultant

John set up the Aston University WebCT server and continues to support it; he has also set up Moodle and LAMS systems for testing and Eprints and Dspace servers for evaluation. He has previously worked on the JNT's X.500 project.

To be appointed

Role: IT expert

To develop the software required to run the e-tool and to enable non-IT specialists to maintain and add to this database after the end of this project. Position to be advertised as soon as funds are secured.

Partners:

Aston University: The learning and teaching strategy at Aston University is driving towards better flexible learning facilities and more appropriate assessment and feedback, this tool addresses both of these points and will provide a hub of e-learning that can be used within the University. In addition the University has plans for a new student learning facility to be housed within the library.

Matthew Boulton College: MBC is an FE college that has recently relocated to Aston University campus. The current links between Aston and MBC are evident in the foundation degree in pharmaceutical technology and the teaching of the Pharmacy technician course. E-tools, such as AMORA offer cross-institutional collaboration to strengthen these links and to demonstrate to students the transition from one institution to another in promoting learning.

University of Central England: UCE is an HE institution located at various campuses in Birmingham, currently there is limited collaboration between UCE and Aston although this project aims to improve links. The NHS skills escalator aims to bring together health professionals and this project links nursing and pharmacy education via a shared e-tool.

Timeplan:

Milestone	Method	Month
Develop question bank of standard problems (written format only required)	Key personnel meet to discuss requirements from each student group	1
Meet with IT expert to discuss how this can be hosted and to describe how we feel the images should map to the maths	Key personnel meet with certain sketched ideas	2
Develop the question bank and images/video clips for review	IT expert to research existing programmes that can be used/adapted to the needs and input some questions	2-6
Review how the developed package meets the criteria set at the outset	Key personnel via email contact or a meeting	6
Design a standard evaluation form for the utility of the package within the pilot groups	Co-ordinator to design a standard evaluation package (to be circulated for comments to key personnel)	6
Pilot the package for user friendly interface and utility in small student groups	Key personnel within each institution to arrange a suitable time and student group	7-9
Refine the tool in terms of usability and comments made by student group and build up question bank	IT expert to use evaluation to review and improve the service as required and to build up the question bank	9-15
Have tool as open access to students and monitor usage and gather feedback on	Key personnel to co-ordinate	12-24

utility etc		
Evaluate benefits to learning and overall utility	Key personnel to administer an evaluation form to review the utility of the system	24
Dissemination of findings via relevant subject specific education journals or meetings	Key personnel to identify relevant meetings or journals to publish the success of this e-tool within the student groups	24
Determine future usage of tool, distribution to additional HE and FE institutions as well as registration bodies for the healthcare professions	Co-ordinator to approach educational institutions to determine interest and to promote this tool	20-24

Deliverables:

An open access e-tool that:

- Allows users to go through mathematical tutorials at their own pace and integrate this with a unique question set to promote conceptual understanding of mathematical procedures.
- Allows teachers to upload mathematical problems related to healthcare with associated images to aid conceptual understanding of mathematical procedures.
- Is an open access source widely available to HE and FE institutions as well as professional bodies within healthcare
- Allows assessment of conceptual and computation errors in mathematical procedures that can be applied in other subject specific courses for non-specialist maths training
- Is WAI (Web Accessibility Initiative) compliant
- Supports HE courses in FE colleges

The evaluation of this e-tool across the institutions provides an exploration of the use of e-learning to support lifelong learning

Risks:

A significant risk is in development of the programming needed to set up the tutorials according to the ideas of the teachers, the PCCAL tutorials will be used as the basis with linked assessment and more relevance to promote learning.

Step-wise assessment will be difficult to design in relation to free flowing thoughts; a prescriptive methodology should be avoided yet the tool should determine where errors occur and whether these are conceptual or programme errors.

If the initial pilot feedback suggest a lot of major changes there may not be sufficient time within the programme to implement these changes therefore close monitoring is required. Also if programming takes a lot longer than expected the question bank may not be as comprehensive as envisaged at the outset.

Future sustainability:

Aston University has been involved in e-learning for a number of years and has used Web-CT supporting material in pharmacy for five years. Pharmacy and nursing are popular courses within higher education and there are many associated subjects that may also benefit from this e-tool; including veterinary technicians and students, dental technicians and students, podiatry students. The findings from the success of this method of teaching mathematics using this tool could also be applied across many other subjects within both higher and further education. This package can also be easily incorporated into the support material for distance learning courses. The NHS Agenda for Change aims to develop a multi-skilled workforce with an escalator system of progression. Pharmacy technicians will have to be registered with the Royal Pharmaceutical Society in the near future and continuing professional development will become mandatory, an e-tool, such as this one is perfect for CPD for this profession. The end e-tool produced will be an open access system with software designed so that individuals can select the question set from the question bank and add to this bank via the engine developed. The student population is growing and, if successful this tool should easily be sustainable across higher and further educational institutes as well as in the workplace via professional bodies such as the RPSGB.

As this will provide an open source e-tool that can be maintained by non-IT specialists this will be maintained by the users for their individual needs. The server at Aston will be provided as this will be an invaluable tool in the teaching of Pharmacy.

References:

- Batchelor, H. K. (2004). The importance of a mathematics diagnostic test for incoming pharmacy undergraduates. *Pharmacy Education*, 4, (2), 69-74
- Coben, D. & Thumpston, G. (1996). Common sense, good sense and invisible mathematics. In T. Kjærgård, K. Aasmund, & N. Lindén (Eds.), *Numeracy, Race, Gender, and Class: Proceedings of the Third International Conference on Political Dimensions of Mathematics Education* (pp. 284-297). Bergen, Norway: Caspar Forlag.
- Department of Education and Employment (1999) *The Moser Report: A fresh start: Improving literacy and numeracy*. London, DofEE.
- Ernest, P (1997). *Social Constructivism as a Philosophy of Mathematics*. Albany, NY: State University of New York Press.
- Fulton, W.H., O'Neil, G. P. (1989). Mathematics anxiety and its effect on drug dose calculation. *Journal of Nursing Education* 28, (8),343-346
- Gatford, J. D., & Phillips, N. (2002) *Nursing Calculations*. Sixth Edition. Churchill Livingstone.
- Gredler, M. E. (2001). *Learning and instruction: Theory into practice*. Upper Saddle River, New Jersey: Merrill Prentice Hall
- Hutton, M. (1998). Nursing mathematics: the importance application. *Nursing Standard*, 13(11), 35-38
- Kapborg, I. (1994). Calculation and administration of drug dosage by Swedish nurses, student nurses and physicians international. *Journal for Quality in Health Care*, 6(4), 389-395
- Kelly, L. E., & Colby, N. (2003). Teaching medication calculation for conceptual understanding. *Journal of Nursing Education*, 42(10), 468-471
- Kelly, N. & Glaspole, S. E. (2006) Formative assessment as a learning aid for pharmacy calculations—a theory based design. *Pharmacy Education*, 6(1), 27-31
- Lesar, T. S., Briceland, L., & Stein, D. S. (1997). Factors related to errors in medication prescribing. *JAMA*, 277, 312-317
- Rees, J. A., Smith, I., & Smith, B. (2001). *Introduction to Pharmaceutical Calculations*. Pharmaceutical Press, London.
- Rolfe, S., & Harper, N. J. N. (1995) Ability of hospital doctors to calculate drug doses *British Medical Journal*,310,1173-1174
- Schoenfeld, A. (1994). Reflections on doing and teaching mathematics. In A. Schoenfeld (Ed.). *Mathematical Thinking and Problem Solving*. (pp. 53-69). Hillsdale, NJ: Lawrence Erlbaum Associates
- Weeks, K., Lyne, P., & Torrance, C. (2000). Written drug dosage errors made by students: the threat to clinical effectiveness and the need for a new approach. *Clinical Effectiveness in Nursing*, 4, 20-29
- Wheeler, D. W., Whittlestone, K. D., Salvador, R., Wood, D. F., Johnston, A. J., Smith, H. L., & Menon, D.K. (2006). Influence of improved teaching on medical students' acquisition and retention of drug administration skills. *British Journal of Anaesthesia*, 96(1), 48-52
- Wilson, B. G. (Ed.). (1996). *Constructivist Learning Environments: Case Studies in Instructional design*. Educational technology Publications. Englewood Cliffs NJ.

Letters of Support:



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To Whom It May Concern

On behalf of Matthew Boulton college of FE & HE, I am happy to support the pilot study of this project. I intend to use this tool during the first year of study with Pharmacy Technicians studying the BTEC NC in Pharmacy Services.

The pharmacy technicians are required undertake simple dose calculations during the first year and progress to more complicated BSA/dose calculations during the second year. This study will be used with all students and as a support to those identified with mathematical barriers.

I am keen to use this study with other students studying healthcare related studies at Matthew Boulton and hope this will be successful as a free fully available learning resource.

Yours truly,

Karen Socci
Lecturer and Assessor in
Pharmacy Services.



Birmingham's
EUROPEAN
Vocational College



21st June 2006

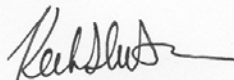
To whom it may concern

Re: AMORA: Applied Mathematics online Reinforcement and Assessment

The online mathematics reinforcement and assessment tool, as described in this proposal, will be valuable for current undergraduate pharmacy students and address a significant need in terms of mathematical competence. The proposal fits with the current Aston University teaching and learning strategy and links with the student learning centre planned for the future. The development of this programme will also enable this e-tool to be utilised within other courses run at Aston University and thus assist greater numbers of students in the future.

This proposal offers value for money with Aston contributing 20 % of the full economic costing. The IT support within the School of Life and Health Sciences is able to support this development and the co-ordinator has demonstrated dedication to teaching and learning within the school.

The School of Life and Health Sciences at Aston University fully support this bid for the benefits of both the School and the University.



Professor Keith Wilson
Deputy Head of Life and Health Sciences



21st June 2006

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Dr Hannah Batchelor
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Dear Hannah,

Your proposal regarding the Mathematics Online Reinforcement and Assessment tool sounds very interesting and thank you for approaching UCE as a potential collaborator in its development. I am pleased to report that after speaking to Simon Walker, Head of Department for Health Care Professionals that we would be happy to assist in its development and think that the tool would be very helpful and practical in facilitating learning in this complex and problematic area.

Good luck with the bid and please do not hesitate to contact us if you require further assistance in this venture.

Yours faithfully

A handwritten signature in blue ink, appearing to read "Maria Kisiel".

Maria Kisiel
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