Mathematics support materials – free for all

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Abstract — *Does your students' ability at algebra make you angry? Do they find differentiation difficult, vectors vile and trigonometry terrible? Help is at hand - **math**centre provides support materials for everyone looking for post -16 maths help. Students who access **www.mathcentre.ac.uk** are offered practical help geared to their specific discipline, with the main presence on the site being help for engineering students. **math**centre provides the students with access to resources of which there are five different types: **Quick reference leaflets** provide easily accessible support on key topics; **Teach-yourself booklets** give a more in-depth treatment of important topics and include theory, worked examples and exercises; **Practice and revision booklets** contain hundreds of practice exercises and answers; **On-line exercises** allow students to test themselves or practice basic techniques; **Video tutorials** offer a face to students to guide them step-by-step through the key topics. Engineering educators who visit the web site can access all of the above resources as well as good practice guides, case studies and third party materials. For those looking for a large number of resources to fulfil their teaching needs there is a "resource pack" section. Each of these packs contains a number of leaflets, workbooks and exercises. **math**centre is being continually developed and resources for engineering academics and students are being added almost on a daily basis. All resources are free and can be used by universities to enhance their local mathematics support provision. This paper will provide a background to the establishment of **math**centre (and its sister-project **math**tutor) and an in-depth look at the resources available and the topics covered.*

Index Terms — ***math**centre, mathematics resources, mathematics support*

BACKGROUND

Since the early nineties there has been a rapid and extensive decline in the mathematical capabilities of students entering a wide range of degree programmes. The urgent need for effective mathematics support has been a key recommendation of every major report on the state of mathematics education for the past decade. That there is a problem has not been in dispute, the reports take that as a given as they go on to "tackle" it [1] and "measure" it [2] and recommend strategies which might begin to address it. The Roberts Review [3] called strongly for action "in person and/or through e-learning to bridge the gap between A-level and degree courses" and most recently the Smith Report [4] in its call for a National Centre for Excellence in Mathematics Teaching recommends "incorporation of relevant existing mathematics support activities and initiatives".

The decline has been observed in students across the entire university sector, irrespective of their entry qualifications. Engineering and the physical sciences obviously place great importance on sound pre-university mathematics education and so a lack of preparedness has significant consequences. In addition, there is mounting evidence that many other disciplines in higher education are encountering problems due to the lack of students' basic mathematical skills. There is evidence of a decline in basic numeracy amongst first-year bioscience undergraduates [5]; studies illustrate a lack of proficiency in mathematical calculation skills amongst student nurses (and indeed practitioners) [6] and call for university-facilitated remedial programmes. A study of several QAA subject overview reports [7,8] reveals that in several disciplines, lack of mathematical competence is a major factor in failure and drop-out rates.

THE DEVELOPMENT OF A UK-WIDE MATHEMATICS SUPPORT FRAMEWORK

Following successful proposals in 2002 to both the Learning and Teaching Support Network (LTSN) and the Higher Education Funding Council for England's (HEFCE) Fund for the Development of Teaching and Learning, work is currently progressing well on the development of a UK-wide mathematics support framework. This framework is being developed to ease the transition from school mathematics to university mathematics in a wide range of disciplines, including engineering. It will help the many students who find themselves ill-prepared for the mathematical demands of their chosen courses, or who

need to revise key topics in school-level mathematics once they reach university. At the same time it is designed to help the staff who teach or support them.

This support framework consists of a website, **math**centre (**www.mathcentre.ac.uk**), and a DVD-Rom disk-set, **math**tutor. After eighteen months of development there is already plenty to see, to use and to extend: **math**centre was launched in September 2003 and now attracts around 700 hits a day; while the first **math**tutor preview disk, on Algebra, received enthusiastic endorsement from students and staff in the schools, colleges and universities piloting it.

mathcentre and **math**tutor are on-going projects, with production extending until at least 2005. The resource base is regularly supplemented and existing resources are being revised as the evaluation process continues. Relevant resources from other projects are being harvested and also made available through the **math**centre website.

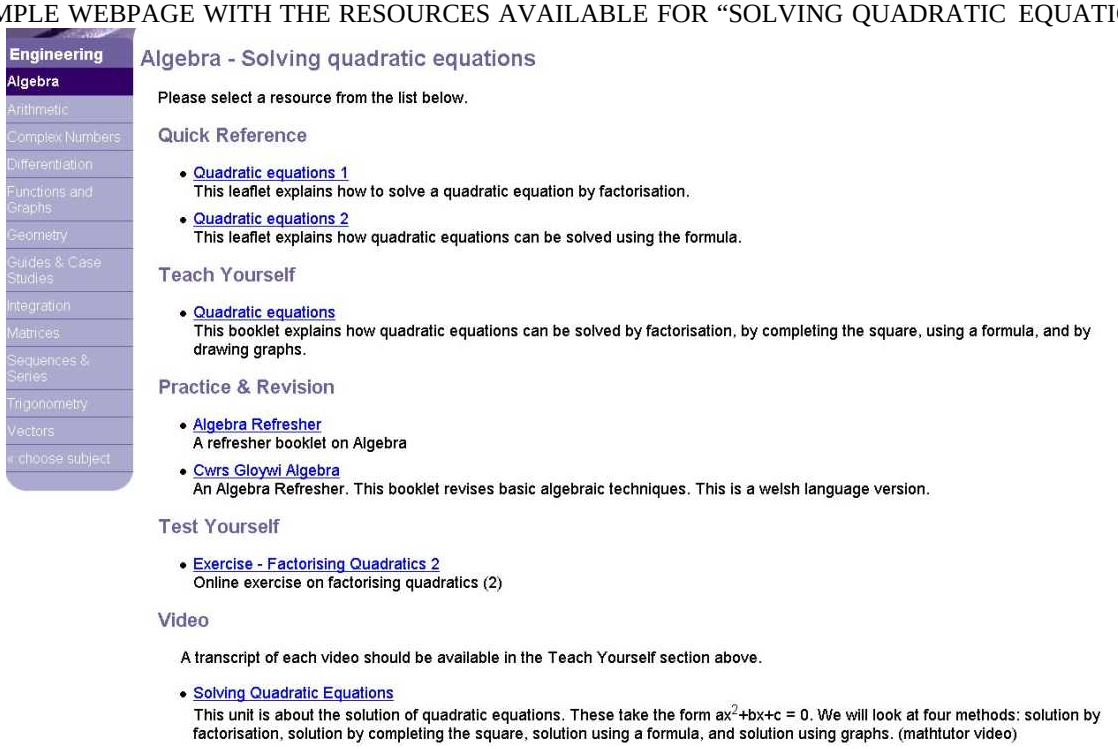
Built on Experience

The people collaborating to provide **math**centre and **math**tutor have many years' experience of running support centres and offering supplementary teaching in their own universities of Loughborough, Leeds and Coventry in the UK. In addition, they have contributed to research and guidance on the kind of help students look for and value [2,9], so it has been a natural development to gather up this experience and offer it on a national scale. With the framework in place it is equally natural for the collaboration to widen, to welcome resources from other projects and individuals working to similar ends. The original, university-based projects, funded through HEFCE and the LTSN are now extending to reach schools with support from the Gatsby Foundation. But however large **math**centre becomes, however many topics **math**tutor covers, only one thing will matter to students: that they can find the help they need easily at the click of a mouse.

MATHEMATICS SUPPORT MATERIALS FOR STUDENTS

In designing the **math**centre website the project team has recognised that students need to find exactly what they are looking for and find it fast. If you're an engineer or an economist you want the maths for your course, nothing else. You want a specific topic; you may want a quick answer or perhaps you want a full explanation; you may want to check your knowledge with a diagnostic or perhaps you want to practise. Figure 1 shows an example webpage with the types of resource on offer to engineering students looking for help with solving quadratic equations.

FIGURE 1
EXAMPLE WEBPAGE WITH THE RESOURCES AVAILABLE FOR "SOLVING QUADRATIC EQUATIONS"

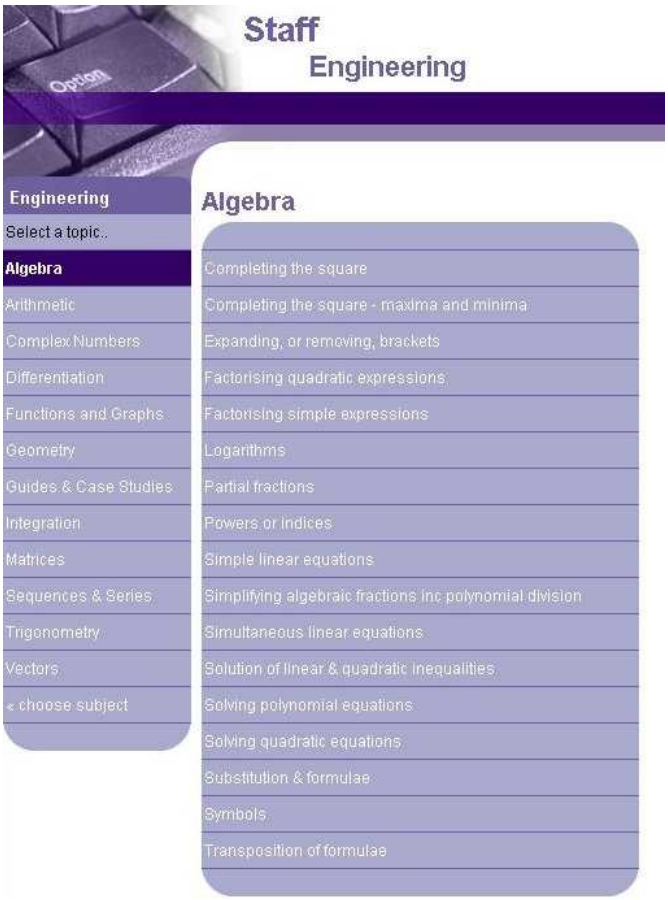


From their study of the work being done in university support centres, Lawson, Halpin & Croft [9] have observed the help students value most to be short, focused handouts and, above all, one-to-one tutorial support. **math**centre provides the students with easy access to these types of resources, classified as follows:

- **Quick reference leaflets** provide easily accessible support on key topics
- **Teach-yourself booklets** give a more in-depth treatment of important topics and include theory, worked examples and exercises
- **Practice and revision booklets** contain hundreds of practice exercises and answers
- **On-line exercises** allow students to test themselves or practice basic techniques
- **Video tutorials** offer a face to students to guide them step-by-step through the key topics.

These five resource types are available for a multitude of topics of interest to engineering students and academics alike, including: Algebra; Arithmetic, Complex Numbers, Differentiation, Functions & Graphs, Geometry, Integration, Matrices, Sequences & Series, Trigonometry, and Vectors. Each topic has a comprehensive listing of sub-topics to ensure that all the maths needed for the transition from school to an engineering degree is covered. Figure 2 gives a full listing of the sub-topics available under the main Algebra heading.

FIGURE 2
EXAMPLE WEBPAGE WITH THE VARIETY OF SUB-TOPICS AVAILABLE FOR ALGEBRA



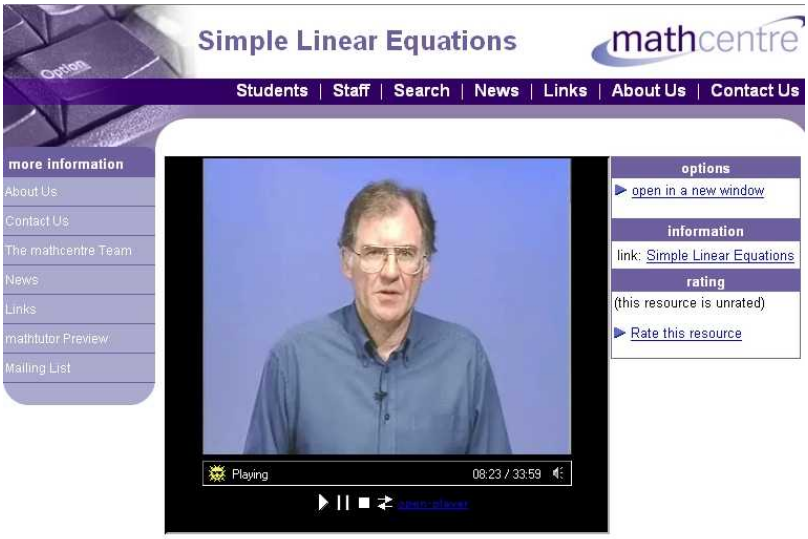
Video Tutorials

Students requiring mathematics support value above all one-to-one tutorial support [9]. Virtual, face-to-face teaching in association with integrated and free-standing text material is therefore at the heart of **math**tutor's digital resources. A bank of over 70 video tutorials is being recorded, digitised, tested, revised and issued on the **math**tutor DVD.

The latest addition to the infrastructure of the **math**centre website is the provision for video streaming. Video streaming is still in its infancy, a luxury which can be enjoyed to the full by those with access to the UK HE/FE SuperJANET networks

or with their own broadband links, but, for those with more basic lowband connections, it can offer only tantalising glimpses into a possible future. The **math**centre team had assumed it would be a distant prospect to offer the video tutorials produced for the **math**tutor DVD through the website, but it is now becoming a reality. This is thanks to the University of Portsmouth in the UK, who have been at the forefront of investment in video streaming technology and its application for learning. Portsmouth have allowed a seamless connection to be created between the **math**centre server and their own, enabling an education user to "click to view Video Tutorial" to reach the video they need, providing them with their own one-to-one tutorial at a time that suits them. Figure 3 shows the video tutorial as it appears seamlessly within the **math**centre website.

FIGURE 3
EXAMPLE OF THE VIDEO TUTORIALS EMBEDDING WITHIN THE **math**centre WEBSITE



Additional Features of mathcentre

As well as other elements of the **math**tutor DVD (such as the interactive diagnostic and practice exercises, giving students a chance to check their understanding), a student will find on **math**centre a searchable database covering many of the key topics relevant to their course, refresher booklets to download and the option to "Ask a tutor" about any aspect of the material on the site. Perhaps most popular are the "Quick Reference Leaflets" on key topics. Over 100 such leaflets are now available for direct access through a searchable database and they are supplemented regularly as new material becomes available.

MATHEMATICS SUPPORT MATERIALS FOR STAFF

mathcentre's home page offers one route for students to follow and another giving further options for staff. University academic and learning support staff who enter this section will find an increasingly wide range of resources to help them tackle the mathematics problem in higher education, and it is already being appreciated. Engineering academics and applied mathematicians are already directing students to **math**centre, where they can find additional help that they do not have the resource to provide themselves, especially for revision purposes. Publicity material, including the **math**centre "Facts and Formulae Leaflet" (a valuable resource in their own right), are supplied to UK engineering academics free-of-charge so that they can make all their students aware of **math**centre and the support they can find there.

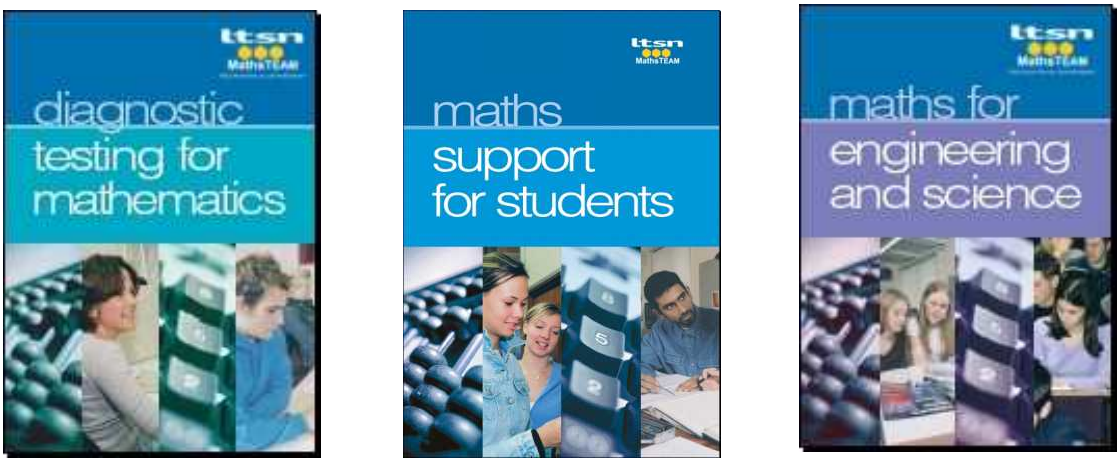
Naturally, staff have full access to all the mathematics materials designed for students; however, rather than downloading the student resources as individual items, many of these have been packaged into convenient blocks for single download from the staff section of the site. These can be used to populate individual institutions'physical mathematics learning support centres, of which there are many in the UK, with approximately 50% of HEIs having some sort of resource of this kind for their students. Alternatively they could be made available from university or departmental libraries.

Best practice guides and case stu dies

Of particular interest to staff are resources available from **math**centre that give advice on supporting students. The establishment of local support structures is covered in the LTSN publication *Good Practice in the Provision of Mathematics*

Support Ce ntres [9]. Then there are the LTSN MathsTEAM publications. The LTSN MathsTEAM was a collaborative project between four subject centres (LTSN Engineering, LTSN Maths, Stats & OR Network, LTSN Physical Sciences and the UK Centre for Materials Education), which recently surveyed the growing number of initiatives directly associated with the mathematics problem. Three comprehensive collections "Diagnostic Testing for Mathematics", "Maths Support for Students", and "Maths for Engineering and Science" were published in April 2003 (see Figure 4). These publications comprise over 60 case studies from universities around the UK, describing the implementation of different learning activities, the support needed for these, the difficulties faced, and the evidence of their success. These case studies are extremely valuable for those looking for ideas to establish or improve their own mathematics support provision.

FIGURE 4
THE LTSN MATHSTEAM PUBLICATIONS



CONCLUSIONS

As a result of the **math**centre and **math**tutor projects all students making the transition from school to university can now have direct access to skilled teaching and high quality learning resources, which revise and refresh basic mathematical techniques before arrival and whilst at university. This gives them the opportunity to plug gaps in their prior knowledge and enable them to take control of remedying shortcomings in complete confidentiality. Engineering educators worldwide can now direct their students to the wealth of resources that are available from **math**centre, and also benefit from freely available, readily accessible mathematics support to stimulate the establishment or enhancement of local provision in an efficient and cost-effective way.

REFERENCES

[1] Tackling the Mathematics Problem, the London Mathematical Society, London, 1995

[2] Savage, M.D., & Hawkes, T., (eds), Measuring the Mathematics Problem, London, Engineering Council, 2000

[3] SET for success: the supply of people with science, engineering, technology and mathematics skills, the report of Sir Gareth Roberts' review, HM Treasury, April 2002

[4] Making Mathematics Count, the report of Professor Adrian Smith's Inquiry into Post-14 Mathematics Education, DfES, February 2004

[5] Tariq, V.N., A decline in numeracy skills among bioscience undergraduates, Journal of Biological Education 36(2), 2002

[6] Sabin, M., Competence in Practice-Based Calculation: Issues for Nursing Education, A Critical Review of the Literature, LTSN Health Sciences, 2001

[7] QAA Subject Review Reports - http://www.qaa.ac.uk/revreps/reviewreports.htm

[8] Croft, A.C., Following up cycles of QAA subject assessments for non-mathematicians, MSOR Connections, Vol.1. No.2. May 2001

[9] Lawson, D.A., Halpin, M., & Croft, A.C., Good Practice in the Provision of Mathematics Support Centres, LTSN MSOR, Birmingham, 2001