

Mathematics Support for Adult Learners

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In 1997 a scheme to help “ at risk” or mathematically under prepared first year undergraduates in the University of Limerick was undertaken by O'Donoghue to assess the extent of the ‘Mathematics Problem’ and try to ascertain the best means of dealing with it. Diagnostic testing was introduced in a bid to diagnose those students who were most prone to failure and/or dropping out. This procedure also served to make students themselves aware of their level of expertise and helped to classify major areas of weakness in the group of first years as a whole. The main intention, however, of diagnostic testing is to identify the support that will be needed to help remedy the situation. It was discovered that 30% of first year service mathematics undergraduates required extra support. This was one of a number of contributing factors leading to the establishment of a Mathematics Learning Centre. In October 2001, the University of Limerick’s Mathematics Learning Centre opened. One of the aims of the Mathematics Learning Centre is to address the mathematics needs of mature students and adult returners. In this paper, the authors discuss the facilities/resources provided by the Mathematics Learning Centre for Adult learners of mathematics in the University of Limerick.

The so-called ‘Mathematics problem’ as it is styled in the UK research on mathematics education encompasses issues in the transition from school mathematics to university mathematics. Similar issues and concerns arise in the Irish context. A collection of descriptions of the ‘Mathematics problem’ has been assembled in Ireland by O’Donoghue (2004) and includes the following:

- Mathematical shortcomings of entering students
- Mathematical deficiencies of entering students
- Pre-requisite mathematical knowledge and skills
- Mathematical preparedness/under-preparedness
- Mathematics at the school/university interface
- Issues in Service mathematics teaching
- Numeracy/Mathematical literacy.

With such a diverse number of career prospects available to students on exit from Higher Education nowadays and the escalating importance of mathematics in such fields as Business, Engineering, Education or Pure Mathematics, there is an obligation on universities to provide a suitable mathematics education for each student.

At present there is widespread concern among third level academics in many countries (e.g. Australia, the U.K.) about the poor level of mathematical preparedness of first year undergraduates in mathematics intensive courses. Research shows also, that the problem is not just that some students are “under-prepared” but that even students with good Leaving Certificate/ A-Level grades struggle with even the most basic aspects of mathematics (LMS, 1995; NCCA, 2005).

Added to this problem is the fact that many believe that not only are students under-prepared, but that there is also a decline in standards and there is evidence in the U.K. to suggest that there has been some grade dilution over the years (Hunt and Lawson, 1996). There are concerns that this under-preparedness will have serious short and long-term consequences not only for individual students (i.e. failure and dropping out (O’Donoghue, 1999)) but also for the professional reputation of various universities and for the economic progress of a country (LMS, 1995; Flynn, 2005). There are fears in the U.K. that a drop in the level of the mathematical proficiency of undergraduates will lead to them falling behind their peers in other countries and, as a result, the country itself will have to rely on others for inventions and developments (LMS, 1995).

The problem of mathematical under-preparedness has also been reported throughout universities in Ireland (Hurley and Stynes, 1986, O’Donoghue, 1999). There is evidence of this drop in standards in Ireland as far back as 1984 when research carried out in Cork Regional Technical College (Cork RTC) drew attention to the problem of the poor mathematical grounding of their first year students. The authors concluded that the incoming undergraduates were deficient in basic mathematics. In the following year, Hurley and Stynes (1986) carried out a similar investigation in University College Cork (UCC) with similar results, their first year students demonstrated poor articulation of basic prerequisite mathematical knowledge. In the late 1980’s in the National University of Ireland, Maynooth (NUIM), and more recently in Dublin City University (DCU), it became apparent that students were having the same troubles as students elsewhere in Ireland. Academic staff initiated diagnostic testing to establish where the weaknesses lay and continue this process to the present day.

Due to mounting concern across the board in the Department of Mathematics and Statistics in the University of Limerick (UL), a study entitled “An Intervention to Assist ‘At Risk’ Students in Service Mathematics at the University of Limerick” was undertaken to gauge the degree of mathematical under-preparedness of first year undergraduate students participating in mathematics intensive courses. Mathematics lecturers complained that students displayed:

- lack of fluency in basic arithmetic and algebraic skills,
- gaps (or in some cases absence of) in basic prerequisite knowledge in important areas of the school syllabus e.g. trigonometry, complex numbers, differential calculus,

- an inability to use or apply mathematics except in the simplest or most practised way (O'Donoghue, 1999, p.3).

A pilot study carried out in the academic year 1997/98 suggested that up to 30% of incoming students were 'at risk' and would need supplementary help to complete first year successfully. Evidence from this study and a similar study carried out the following year convinced the author(s) that the problem would persist and take on a permanent disposition (O'Donoghue, 1999).

The UL Study

In the past decade there has been increasing unease amongst lecturers in the University of Limerick (UL) as regards the mathematical competence of first year students participating in mathematics intensive courses. Lecturers observed that students were by no means articulate in certain topics which are not only present on the Leaving Certificate syllabus, but provide a foundation for third level studies in mathematics e.g. Trigonometry, Calculus, Complex Numbers to name but a few. Students also displayed unsophisticated approaches to basic arithmetic and algebraic problems and became perturbed when presented with problems posed in a dissimilar way to what they were used to.

It was (is) felt that lack of competence in the field of mathematics

- Increases student failure rates and deflates self esteem,
- Hinders progress in other areas of the degree they are pursuing i.e. Engineering, Physics, Chemistry, Business etc.,
- Diminishes standards of degrees.

A study to help "at risk" or mathematically under-prepared first year undergraduates in the University of Limerick was undertaken by O'Donoghue (1999) to assess the extent of the problem and try to ascertain the best means of disentangling, or at least dealing with it. A pilot study was carried out in the academic year 1997/98 on first years undertaking Technological Mathematics 1 & 2. In the subsequent year, the project was extended to students taking Science Mathematics 1 & 2 also.

Diagnostic testing was introduced in the University of Limerick in a bid to (as the name suggests) diagnose those students who were most likely to fail. This procedure also served to make students themselves aware of their level of expertise (or lack of it as was often the case!) and classify major areas of weakness in the group of first years as a whole. The main intention of diagnostic testing is to identify the support that will be needed to help remedy the situation.

For the pilot study (1997/98) 257 (out of 308) Technological Mathematics students sat a 40 question diagnostic test in the third week of the first semester. Students who scored less than 20 were deemed to be "at risk". There were 69 (27%) in this category. A two-pronged strategy was put into action: a combination of support tutorials and a

front-end skills package. It was not obligatory but it was strongly advised that the “at-risk” students attend these additional (support) tutorials (1 per week) for the duration of each semester. In these tutorials, students worked with their tutor on significant difficulty areas highlighted by the diagnostic test. These tutorials, taught by qualified secondary school teachers, were habitually student-led. A front-end skills package in arithmetic and algebra was formulated and there were four tutorials (two each week) held based on this package. This was completed early in the process. The project team kept records of students’ results and attendance and developed a database of this data. Statistics showed that students who availed of the services provided attained good results in the end of term exams.

The aims and objectives of the ensuing year (1998/99) were analogous to those of the preceding year with a supplementary one apropos identification of required facilities to comprise computing/ Internet resources. This particular goal was achieved by providing extra MAPLE classes (supervised by post graduate students) and CALMAT tutorials for students. One other divergence from the previous year was that the diagnostic test was administered in week 1 of term instead of week 3 because it was felt that there would be a superior turn out at this time, which there was.

Each term, in addition to two lectures and one problem session (given by a lecturer), there was one tutorial per week (usually taught by a post graduate student) for everyone although attendance was not mandatory. Again, a database of statistics was maintained right the way through both semesters and results were comparable to those in the previous year. The project team observed that while some of the “at risk” students still failed, the results of those who did not attend special tutorials were inferior to those who did.

It was discovered that 30% of first year service mathematics under graduates required extra support. While the support tutorials showed improvements for the most part, tutors and students alike felt that a more individualised structure was essential to reach those who were, perhaps, lost in larger group situations. Analysis also showed that certain mathematical topics were not given as much attention as they should have received and in some cases, no attention at all (O’Donoghue, 1999).

In the academic year (2000/01) in addition to other services, students received access to three timetabled hours of supervised CALMAT sessions on a “self-help” basis. This did not prove successful as students did not feel confident working alone and were often lacking relevant information necessary for using this package. This was one of a number of contributing factors leading to the establishment of a Mathematics Learning Centre. In October 2001, the University of Limerick’s Mathematics Learning Centre opened.

The UL study was unprecedented in Ireland. It was a very important study in that it provided empirical evidence which exposed the extent of the problems of mathematical under-preparedness in third level service mathematics courses. It identified many of the factors (internal and external) that contribute to this problem and paved the way for the delivery of effective support services including the development of a Mathematics Learning Centre, the first one in Ireland. In addition, a database of diagnostic test and end of semester results was initiated in the academic year 1997/98 and is updated annually for research purposes.

Ethos of the Mathematics Learning Centre

The Mathematics Learning Centre (MLC) is a special initiative of the Department of Mathematics and Statistics at the University of Limerick (UL). The purpose of the MLC is to support students' learning across all programmes in UL by:

- Delivering appropriate support for students on service mathematics courses,
- Providing a dedicated area with supervised access to help and resources,
- Addressing the needs of special groups (e.g. mature students, adult returners, transfer students etc.),
- Researching the needs of learners in terms of materials, pedagogy, delivery systems and other supports.

All services are based on a supervised self-help model that integrates faculty members, students, media and Information and Communication (ICT) inputs and approaches.

Management and Staffing

The management of the MLC is entrusted to the full time manager whose duties include administration of diagnostic testing, maintenance of the UL database, timetabling and staffing issues and organisation of support tutorials to name but a few. At present there are 12 PhD students who work in collaboration with the manager in the MLC.

Resources and Facilities

The Drop-In Centre

The MLC is open from 10am to 12pm and 2pm to 4pm Monday to Friday and 6pm to 8pm on Thursdays. The centre operates a drop-in facility so students do not have to make appointments and provides free one-to-one consultations. The centre is fully supervised with the manager and two postgraduate students on duty at all times. The timetable of teaching assistants/tutors is displayed on the notice board as different postgraduates specialise in different areas e.g. pure mathematics, applied mathematics, statistics etc. so students are aware when the best times to attend for their own individual needs are.

Diagnostic Testing

The Centre continues to carry out diagnostic testing (approximately 450 students each year) and uses the results to identify and inform those students who would need supplementary help to complete first year successfully.

Support Tutorials

Support tutorials are set up and taught on a weekly basis in addition to regular tutorials. Due to the high number of mature students present, a special tutorial is also run for

mature students in each group in addition to the classes for the other students. Support tutorials take place in the evenings so as not to interfere with regular lectures and tutorials. These are taught postgraduate students or the manager. These classes last for approximately one hour and are student led. The numbers in these groups are quite small (less than 10) for maximum benefit.

Textbooks

The MLC has multiple copies of all the required textbooks for the various mathematics courses in UL. Students are invited to use the textbooks while in the centre but are not permitted to take them away. Other resources include Loughborough University's 'Engineering Maths First Aid Kit' and HELM (Helping Engineers Learn Mathematics).

Computer Assisted Learning (CAL)

There are 5 computers in the MLC which provide access to CALMAT tutorials. The authors have discovered that students prefer one-to-one consultations to these tutorials so they have not proved very successful but remain available.

Examination Revision Programmes

For the week prior to examinations, due to the high numbers in attendance, the manager organises revision programmes for all the main service mathematics courses. Students are divided up by surname and are informed several weeks prior to these sessions of times to attend and to which particular room they must go. These revision programmes are taught by the postgraduate students and focus on the previous year's examination paper. These have proved incredibly popular with 1134 attendances in this particular week alone in the second semester of 2005/06.

Peer Tutoring

One of the new developments in the MLC was the introduction of peer tutoring. Student teachers who do Physical Education (PE) degrees in UL have the option of taking mathematics as an elective. These students have teaching practice in primary and second level classrooms throughout their degree programmes. The MLC decided to tap into this resource and ask for volunteers to teach mathematics to mature students on Access courses. This has proved very successful with two rewarding outcomes: the mature students get one-to-one help from qualified mathematics teachers and the PE students get extra teaching experience.

Online Support

The MLC website provides online support for students on service mathematics courses in UL (Figure 1).

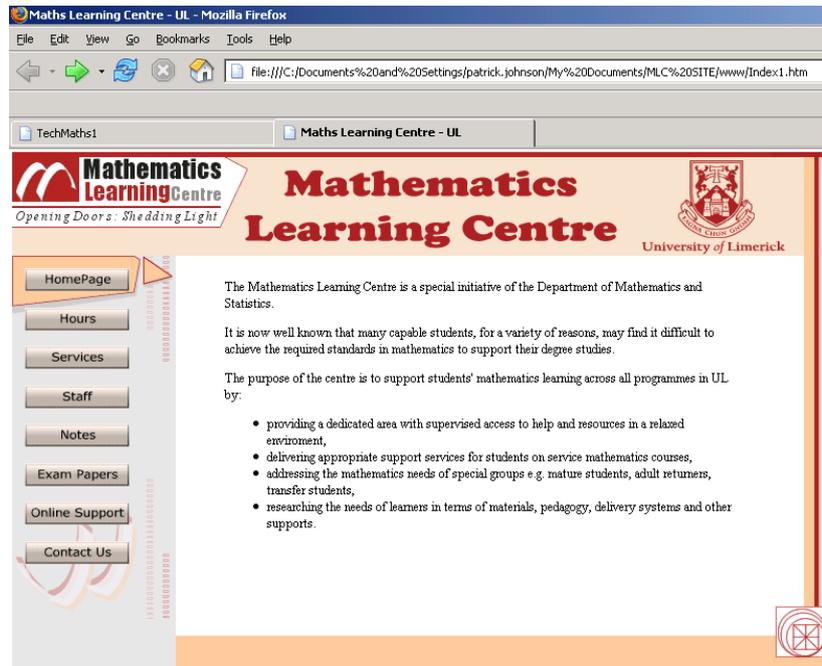


Figure 1 MLC Website Template

On this website, students have access to past examination papers and sample solutions for their specific courses (Figure 2).

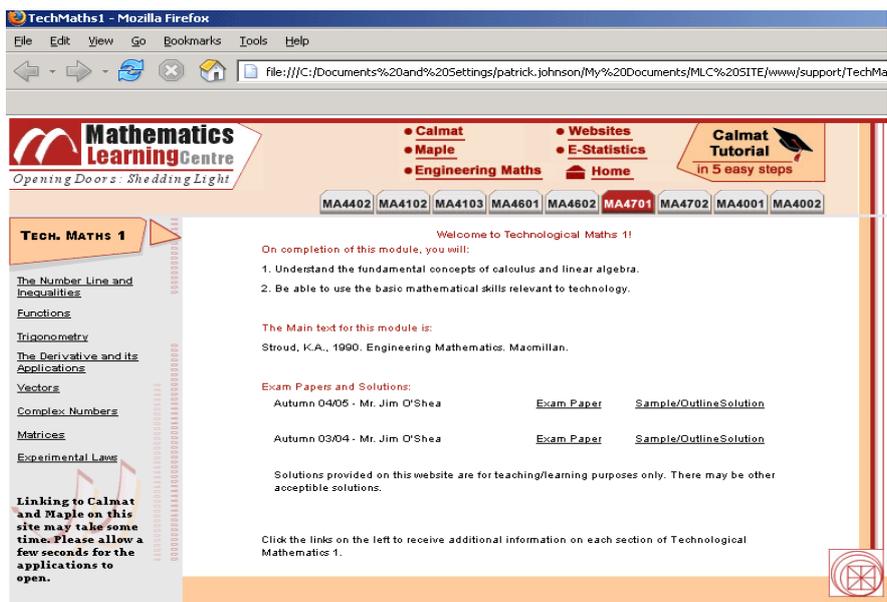


Figure 2 MLC Website

At present the website is being developed to improve the appearance of the website itself and to provide help specifically designed for each service mathematics course (Figures 3 & 4).

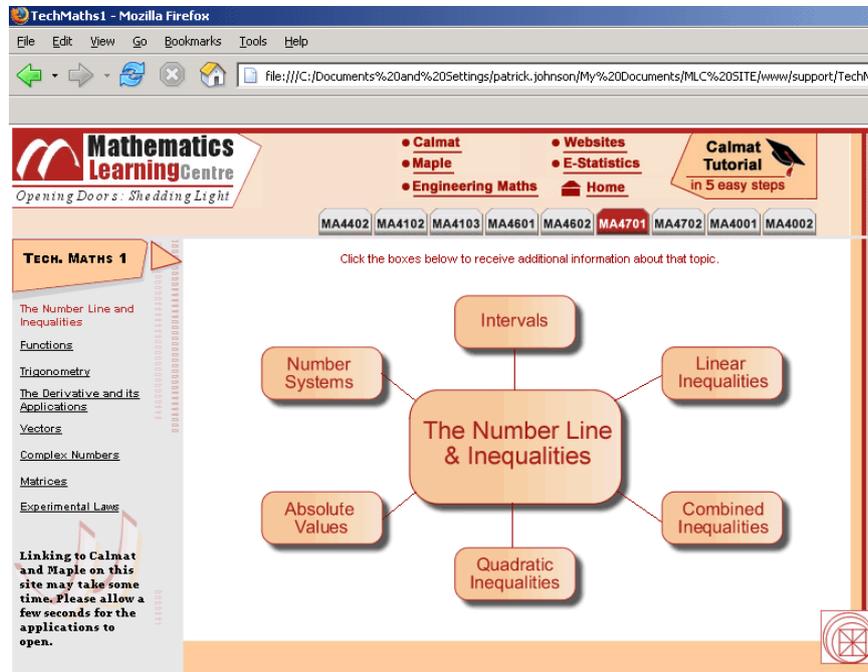


Figure 3 Development of Website

Students are invited to print off notes on any area of their mathematics course that they are having difficulty with.

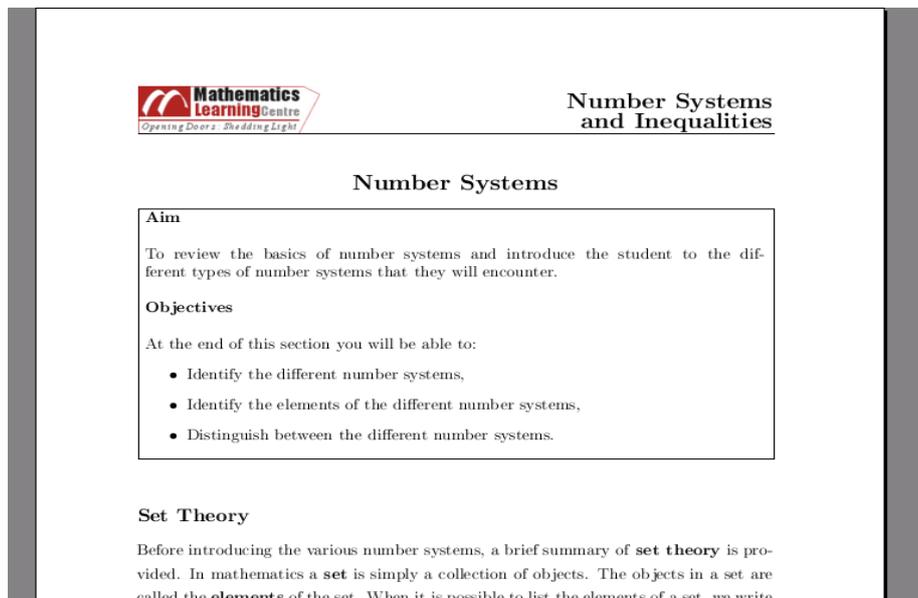


Figure 4 Samples of Notes Available on MLC Website

Measuring the Effectiveness of the MLC

It is hard to gauge the success of such an establishment but it has proved very popular with students from all different faculties e.g. Colleges of Business, Education, Engineering, Science and Informatics and Electronics. In the academic year 2001/02 there was a total of approximately 3353 service contacts (1516 to drop in centre and 1837 to support tutorials) by 431 individual students with the Mathematics Learning Centre (MacMullen, 2002). By the academic year 2004/05 this had increased significantly as there were over 5,200 contacts (Table 1) between the drop-in centre and support tutorials (Gill, 2005). This shows the growing need for such an innovation to be made permanent in universities today.

Table 1 Statistics for U.L. MLC and support tutorials, 2004/05

	Semester 1	Semester 2	Whole Year
Number of Support Tutorials Held	134	132	266
Number of Individuals at Support Tutorials	339	385	607
Number of Attendances at Support Tutorials	1062	1212	2274
Number of Attendances at Drop-In Centre	1395	1545	2940
Number of Individual Students at Drop-In Centre	921	1019	1082
Total Number of Individuals Using Drop-In Centre and Support Tutorials in 2004/2005	1011	1308	1337
Total Attendances at Drop-In Centre and Support Tutorials in 2004/2005	2457	2757	5214

‘At risk’ students are defined as students who are at risk of failing their mathematics module as judged from scores on the diagnostic test (less than 20 out of 40), in which case they will have to re-sit the examination or repeat the whole year if they fail it a second time. The worst-case scenario is that these students may end up dropping out of their studies altogether. It is these students that the Mathematics Learning Centre wishes to prioritise in terms of services supplied. All students are welcome but those who are at risk are one of the top priorities. Most of these students need extra tuition to pass their mathematics courses. If help is given, students can then spend more time keeping abreast of their other studies.

Gill (2006) used the UL database to compare the results of the end of term examinations of those students who are characterised as at risk and participated in the MLC support tutorials with those who did not attend to see if there was a difference in examination performance. It was shown that students who do participate in these support tutorials do tend to outperform those who do not attend.

Table 2: Mean scores on semester 1 examination for students in at risk category

	1997/98	1998/99	1999/00	2000/01	2001/02	2002/03
Did attend support tutorials	68.4%	58.6%	41.2%	37.0%	46.1%	48.3%
Did not attend support tutorials	48.9%	49.0%	25.2%	32.1%	46.9%	51.7%

Table 3: Mean scores on semester 2 examination for students in at risk category

	1997/98	1998/99	1999/00	2000/01	2001/02	2002/03
Did attend support tutorials	66.0%	63.4%	52.3%	49.3%	65.8%	58.2%
Did not attend support tutorials	47.3%	53.7%	44.9%	40.2%	51.5%	52.2%

There is a distinct, if not decisive, advantage for those students in the ‘at-risk’ category who attend support tutorials over those who do not attend as measured by the results on the next and subsequent university examinations (mathematics).

Unfortunately, these attendees are in the minority so some action needs to be instigated to reach all those who need help but are not availing of it. Analysis of the UL database showed that 78.3% of those deemed to be in need of them, failed to attend the support tutorials in the first semesters and 78.5% in the second semesters. These are very high percentages. It is difficult to surmise why they are not attending. The classes are held outside their regular timetable hours (usually in the evenings) so as not to interfere with their ongoing studies. While on the surface this looks like a good course of action, many of these students have heavy timetables and may not relish the thought of ‘extra hours’. Many, particularly the mature students have work and family commitments and so are unable to attend but this is not the case for everyone. It seems that some intervention must be implemented to reach those who require help but are not currently availing of it.

Research in the MLC

Research was viewed as an important support activity for the Mathematics Learning Centre from the outset. A number of projects were undertaken. A short selection of completed projects is listed below and currently a number of projects are in progress.

Gill, O. (2006) *What Counts as Service Mathematics? An Investigation into the ‘Mathematics Problem’ in Ireland*, unpublished thesis (PhD), University of Limerick.

Golding, G. (2006) *Learning Support for Adults Learning Advanced Mathematics: The Case of Adults Learning Vectors*, unpublished thesis (PhD), University of Limerick.

Lehane, J. (2006) *Active Learning in Secondary School Mathematics: Focus on Algebra*, unpublished thesis (M.Sc), University of Limerick.

Vilkomer, T. (2005) *An Analysis of the Theoretical and Practical Aspects of the Identification of Mathematically Gifted Students (with special reference to Krutetskii and Kolmogorov)*, unpublished thesis (M.Sc), University of Limerick.

Murphy, M. (2002) *Mathematical Underpreparedness Among Third Level Entrants: The Possible contribution of the Second Level Mathematics Experience*, unpublished thesis (M.Sc), University of Limerick.

Future Developments

Experience has shown that students value personal interaction most highly. However it is not always possible to provide this so there is a need to invest in online services and to customise these for student use out of hours and off campus. We have identified a need to address pedagogical issues such as teaching and learning approaches for various groups e.g. tradition age students, mature students and students on different degree programmes. Allied to this is a need to improve our tutor training.

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