

A Review of the Engineering Maths First Aid Kit and the Algebra Refresher

Glenys Coleman ■ Department of Engineering ■ University of Lancaster

Abstract

New support mechanisms have been introduced for Engineering students in their first year at Lancaster University to help maintain standards in all subject areas that are underpinned by Mathematics. Resources that have already been developed by Loughborough University are being used in a slightly modified form to help students to work through and overcome any weakness in Mathematics. Help sheets from Engineering Maths First Aid Kit are used to reinforce student learning. All material is used with the help of tutors to form a good foundation for further studies.

The Execution

The Department of Engineering at Lancaster University has a policy of course assessment that leads to discussion of teaching techniques and the current relevance of course content. Following such an assessment, it was decided to carry out a review of the Mathematics modules common to all the first year students taking Engineering degrees.

Concerns were expressed that standards in Mathematics had been falling for some time, particularly the ability to deal easily with algebraic manipulation. The loss of this particular skill was felt to be causing problems, not only in Mathematics, but also across the full spectrum of Engineering modules. A lowering of standards was not considered to be acceptable, as this would cause problems in the later years of the degree. Finding a method of supporting students with areas of weakness in Mathematics was deemed to be an appropriate way forward.

This support has been put into operation at the beginning of the current academic year, 2001/2002 and consists of support prior to starting at the University and extra resources during the first year of study.

This support is in three parts:

- Prior to starting at the university, a student who has been accepted for an Engineering course with a non A level qualification in Mathematics or who has achieved D or E grades at A level, was sent an adapted copy of 'An Algebra Refresher', the booklet designed by the Mathematics Learning Support Centre of Loughborough University. A letter was sent with this booklet encouraging the student to work through the questions and to contact the tutor concerned with support if problems arose. This was followed by a telephone call by the tutor to all such students to check on progress.
- A diagnostic test is given in the first Mathematics lecture. This is not a multi-choice test as the method of solution is considered to be as important as the correct answer. The questions are designed to contain repeated elements, such as expanding brackets, so that individual areas of weakness can be identified before the end of the first week of study. Any problem areas are explained to the student and help sheets from the 'Engineering Maths First Aid Kit' are supplied in appropriate topics.
- At the end of each week of study, workshops are held for students to work through examples with help from tutors where necessary. The ratio of students to staff gives the opportunity for one-to-one teaching, with help sheets from the 'Engineering Maths First Aid Kit' being offered where the tutors or, more often, the students feel these would be helpful.

Two booklets have been considered for the pre-university support, both developed by Loughborough University.

- 'Foundations of Engineering Maths, a Refresher', contains useful topics other than algebra such as basic trigonometry, logarithms and polar co-ordinates. The format of this booklet leaves very small spaces in which to work and is based on multi-choice answers. The format is felt to be less inviting than that of 'An Algebra Refresher'.
- 'An Algebra Refresher' is not multi-choice and contains many more exercises for the student. The format leaves large, blank spaces which invite the student to write down the working so that this forms part of the booklet; a good technique for revision. As the lack of algebraic skills is the main concern, this booklet is considered to be the correct choice in this case. However, the original booklet contains work that is somewhat beyond the level required and the last two sections, 'Solving Some Polynomial Equations' and 'Partial Fractions', were removed. Both of these topics are taught in the first five weeks of study and for some non A level students these topics are new rather than revision.

The use of the 'Engineering Maths First Aid Kit' has enabled the students to take more decisive action when further practice is needed. The help sheets from this pack have become a popular source of help, not only for students whose Maths is generally weak, but also for those who need help in specific areas. A new help sheet on error bounds had to be hastily produced to meet the requests of students. This will be revised and added to the list for the next academic year. Help sheets on other topics such as differential equations may well be developed in the near future. The help sheets are available at all times from the Engineering Office so that the information is available for other Engineering subjects as well as just for Mathematics.

What Support Was Needed?

The support is being offered to the students by a tutor who has worked in schools and in Further Education. The tutor has specialised in teaching Mathematics to Engineering students for some years and is well aware of the problems that some of the non A level students face. No formal staff training has been given but a copy of the 'Engineering Maths First Aid Kit' has been made available to all tutors involved in teaching first year Engineering courses. The methods of introducing the help sheets from this pack were discussed before the start of the current academic year. There are two tutors involved in the workshops who have many years' experience in both schools and Further Education colleges. The diagnostic test seeks to identify students who are likely to have difficulties with Maths and to put the students into workshop groups led by these two tutors.

The Barriers

One of the barriers to the successful implementation of the pre-university support has been a reluctance on the part of students to ask for help, despite being contacted by telephone. This reluctance is understandable and it may be that a 'Maths First Aid' desk could be made available during the introductory week, giving students the opportunity to talk over problems on a face-to-face basis.

The Enablers

The tutor responsible for introducing the support strategies was also the Maths lecturer for the first five weeks. This gave an opportunity to talk to all the students and explain how to access the available help. As the tutor is based in the Engineering Department, forming good relationships with the students simply by becoming a familiar face with whom to stop and chat on an informal basis was reasonably easily achieved. The tutor teaches in the workshops throughout the year giving continuity of support along with colleagues from the Maths and Engineering Departments.

Evidence of Success

This support strategy is in the first year of implementation. Any evaluation at this stage can only be used as a guide and further verification, or otherwise, must be sought over a much longer period. An attempt to assess the effect of the support has been carried out using two methods.

- A questionnaire was given to the students who received the pre-university support. Approximately 75% of the questionnaires were returned. All of the students who responded stated that they had worked through at least some of the booklet and found this easy to use. There were requests from more than half of the respondents for revision on other topics such as calculus and much the same number that felt an area to 'drop in' for Maths help during the introductory week would have been useful.
- The coursework and tests marked so far this year were compared with the results at the same stage from the previous two years. Comparisons were made between three groups of students over the three years. Group 1 consisted of those students entering the university with non-A level qualifications and D or E grade in Maths at A level, group 2, B or C grade in Maths and group 3, A grade in Maths. The A grade group were separated as this year they have not taken the normal Engineering Maths course but have studied with those students majoring in Maths. This is another form of support, encouraging the 'high flyers' to stretch their natural ability for Maths. Figures comparing last year's groups with this year show little change except for a substantial fall in the average mark for the calculus module in group 1 and a lesser fall in group 2. Other marks remained very similar. The first year students of 1999-2000 achieved much better marks overall than the two later years despite more than half of these students entering the course being in group 1. It is interesting to note that this particular year had a larger than average intake of mature students, many of whom are in this group.

Unless there are significant changes, either for the better or for the worse, the effect of the support may be difficult to assess analytically. There are constant changes to pre-university education as well as in-built variation of students. The final exam marks cannot be compared, as this year's intake has not yet reached that stage, and this may be significant. It is hoped that a clearer picture may be gained by carrying out a full statistical analysis at that time. The subjective impressions of experienced staff may well be needed to supplement any analysis.

How Can Other Academics Reproduce This?

The funding for the materials required for this form of support is very modest. 'An Algebra Refresher' is now available through the Learning Teaching and Support Network (LTSN) in a form that can be produced with the logo of the individual university. 'Engineering Maths First Aid Kit' by Dr. Tony Croft is available from the publishers at a very modest price and there are no photocopying restrictions on the help sheets after that initial cost.

The main cost incurred is through staff time, contacting students prior to the start of their studies. All universities have a tutor or workshop system where familiarisation with the help sheets could be introduced. It is recommended that the help sheets should be kept in an area where students can have easy access to them. It is also important that the staff involved should be approachable.

Quality Assurance

Monitoring of the marks achieved by students over each complete academic year is an objective method of measuring the success of support given. This will be carried out for the current year and for at least the next two or three years.

First year tutors meet regularly to discuss progress and any current problems. This is already used as an opportunity to exchange information about how the new support mechanisms are impacting on other subjects. Although feedback from such meetings tends to be subjective, it is no less valid.

Student comments, both formally through department questionnaires, and informally through constant contact in the relaxed atmosphere of workshops, are noted. The response of students is arguably the best measure of any support strategy.

Other Recommendations

This project is in its infancy and there are several areas that need improvement or expansion, if an appropriate level of funding can be obtained.

- The pre-university support could be offered to all students.
- Materials could be sought or developed in-house that cover other topics in a similar manner to 'An Algebra Refresher'.
- The 'Engineering Maths First Aid Kit' could be used as a model to develop help sheets to cover other topics such as differential equations and statistics.
- A 'drop-in' clinic should be made available during the first few weeks of study. This could be on a very modest scale using one small room and one-to-one teaching. No special equipment needs to be used.
- The culture of support could be extended beyond the first year as the techniques taught are often applied in the later years when further revision is required.
- Early support can help decrease failure and dropout rates. Appropriate investment in this area should pay for itself in successful students.

References

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