

# Teaching Students with Diverse Backgrounds

## Streaming Undergraduate Physicists for Mathematics Teaching in Year One

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### Abstract

Many departments of mathematics, physics and engineering now use some form of diagnostic test to assess the basic mathematical skills of new undergraduates [1]. Results reveal that a typical cohort consists of students with a diverse range of mathematical backgrounds and capabilities. Tests also help to identify those students who lack both confidence and competence and are deemed to be at risk of failing or dropping out in Year One.

It is now commonplace for those teaching first year mathematics to be faced by an inhomogeneous student cohort and all are in accord that it has become almost impossible to teach them effectively together. It is against this background that streaming of first year undergraduate physicists into two more homogeneous groups has been introduced at the University of Leeds. The aim is to provide more effective teaching and mathematics support that will get students up to speed and mathematically prepared for their second year.

### Level of Material: First Year

### The Execution

The case study begins in Intro Week with a diagnostic test. Subsequently students are streamed for all first year mathematics modules.

**Intro Week:** Students take a written diagnostic test during Intro Week to assess their basic mathematical capabilities in arithmetic, basic and further algebra, trigonometry and calculus. They are then allotted to either Group A or Group B on the basis of their test performance. There is negotiation with students who are close to the borderline to decide which group might be most suitable for them.

**Modules:** In Semester 1, students take both a 5 credit and a 10 credit module

Maths Consolidation, (5 credits), 1hr/week

Maths for Physicists 1, (10 credits), 2hrs/week.

In Semester 2, there is one 10 credit module

Maths for Physicists 2, (10 credits), 2hrs/week.

#### Remarks:

- In Semester 1, there are 3hrs/week for mathematics teaching. Group B uses all 33 hours whereas Group A uses 30 hours at most.
- Printed notes are used, enabling students to engage in discussion and in doing examples during lectures.
- The first four weeks are given to reviewing and consolidating basic A-level Maths skills.
- An additional "Booster Maths class", 1hr/week, is provided for specific students needing extra teaching/practice with basic skills.

- Students attend a weekly examples class, with attendance compulsory and at most 30 students in each class.
- Module assessment is via marked assignments and a written examination that contribute 15% and 85% respectively.

A major aim of the first year mathematics programme is to engage students in doing mathematics by confronting and solving problems. It is made clear to students at the outset that attendance at examples classes is compulsory and assignments are to be handed in regularly and on time. Of central importance, therefore, is a procedure for continuously monitoring students' attendance, attitude and performance.

Students who miss consecutive classes and/or fail to submit work are asked to explain their record to the Year Convenor and in some cases with the Head of Department.

### Pre-requisite Knowledge

The only requirement is for students to have at least a grade D in A-level mathematics. In our experience the A-level grade itself is an unreliable indicator of a student's mathematical knowledge and ability. The function of the diagnostic test is to provide a profile of what each student can and cannot do.

### How Are Students With Different Mathematical Backgrounds Supported?

The function of 'streaming' is to provide an effective support mechanism for students from different mathematical backgrounds with different levels of preparation. The Booster Maths class gives additional mathematics support to those who most need it and are considered to be at risk.

## What Support Was Needed?

It is essential to have the support of the Head of Department and other members of staff, all of whom recognise that:

- Mathematics is the modelling language for physics and engineering.
- Students who are mathematically ill-prepared on entry need special attention in order to bring them up to speed in Year One.
- Good mathematics teaching in Year One is essential since many students have been 'put off' mathematics during their school experience. Both lecturers and the Booster Maths tutor have considerable experience teaching mathematics to (a) sixth formers (TR) (b) Open University students (MDS, SW) and (c) first year undergraduates (MDS, TR, SW).

## The Barriers

A major obstacle is the lack of motivation in students who fail to see the purpose of mathematics. In fact many academic physicists have reported [2] that their new undergraduates regard maths and physics as two different disciplines. In particular they fail to see mathematics as the modelling language for both physics and engineering and this is, in part, due to a trend over the past decade to reduce the use of mathematics within A-level physics. Hence teachers of mathematics to first year undergraduates in physical or engineering science have a doubly difficult task. On the one hand they must ensure that the basics are understood and well practised whilst on the other, they have to motivate each mathematical topic by illustrating how it connects with ideas and topics within their physics and engineering courses.

A second obstacle is the reason frequently given for not introducing streaming, namely the non-economic, additional cost of employing a second teacher. Superficially this may appear a compelling reason for maintaining the traditional teaching format. However, recent experience at Leeds has shown that this initial, extra investment can be repaid several times by substantially reducing the drop out and failure rates in Year One – i.e. streaming can be a cost effective policy.

## The Enablers

Specific strategies for promoting student participation are

- When referring to Group B students the Maths Team and the Department are careful not to use emotive terms that could label them as second-rate. These students are simply recognised as being ill-prepared at the outset and so receive teaching appropriate to their needs. Otherwise the two groups are treated exactly the same; they do the same course, they are assessed in the same way and high achievements are expected from both by the end of year one.
- The provision of a Booster Maths class for students at risk.
- The provision of examples classes, each with under 30 students, staffed by lecturers and postgraduates who offer help and encouragement.

- The provision of a 5 credit, super-numeracy Maths Consolidation module in the first semester. This is found to be very effective in engaging students early on to consolidate and develop their algebraic, trigonometric and calculus skills. The module is tested in week 8 (pass mark 70%) with a re-sit in the normal examination period in January. As a result, students are able to see before the Christmas vacation how much progress they have made with basic skills since the diagnostic test!
- The introduction of streaming in all first year maths modules. Though some progress is made in Semester One, it is in the second semester that the real effect of streaming becomes apparent – when Group B students have gained substantial confidence and can produce good and in some cases excellent examination performances.

## Evidence of Success

The success of the case study is demonstrated via

- Student feedback (module questionnaires).
- Attendance at examples classes and submission of assignments.
- Examination results.
- Reduced drop out and failure rates.

## How Can Other Academics Reproduce This?

Streaming for first year mathematics teaching could be applied to students in mathematics, physical science, engineering or indeed any maths based degree scheme.

## Quality Assurance

All modules and courses in Physics and Astronomy undergo annual review where feedback on teaching and assessment is examined. The QAA review panel (2000) commented favourably on the department's provision of mathematics support to first year students.

## Other Recommendations

A necessary requirement for the case study to succeed is the setting up of an effective Maths Team that is fully attuned to the Department's aim and objectives for first year mathematics teaching and support.

### References

- [1] *Measuring the Mathematics Problem*, Engineering Council, London, Hawkes, T., and Savage, M. D., (2000).
- [2] Professor Stuart Palmer, Guardian University Guide, 26 Oct, 1999.

