

# National Perspective on Diagnostic Testing

## Introduction

Many Engineering, Physics and Mathematics departments throughout the UK are carrying out diagnostic tests to assess the current mathematical ability of students on entry.

**Question: In 2001 were new undergraduates in your department given a mathematics diagnostic test?**

	Number of Responses	Yes	No
LTSN Engineering	59	38	21
LTSN Maths, Stats & OR Network	54	32	22
LTSN Physical Sciences	50	31	19
The UK Centre for Materials Education	8	2	6
TOTAL	171	103	68

**Table 1:** LTSN Diagnostic Testing Survey, April 2001

Table 1 shows the findings of a departmental survey conducted in April 2001 by LTSN Engineering, LTSN Maths, Stats & OR Network, LTSN Physical Sciences, and the UK Centre for Materials Education. Academics were asked to confirm whether their department conducted diagnostic tests or not and the results indicated a large number of institutions were. Exploring these facts further, descriptions based on the types of testing were submitted to the LTSN MathsTEAM Project at the beginning of 2002.

In most cases, the diagnostic test was carried out during the induction week or the first few weeks of the academic year. The number of students sitting the test varied; the figures submitted went as high as eight hundred. The methodology for the tests ranges from simple paper-based tests through computer generated multi-choice questions to intelligent diagnostic systems.

The tests are not standardised, but in several departments the same diagnostic test has been used over a number of years. Each covers a variety of mathematical topics and departments use the results to assist the students in different ways – to devise approaches to adjust the mathematics teaching and curriculum to the needs of the group and also to inform subject specialists' expectations of their students' mathematical abilities. Primarily the test is being used to help departments to devise strategies to support students with differing attainments [1].

The results from the April 2001 survey indicated a large number of universities were assessing numerical skills on entry to higher education. To develop a further understanding of the testing process within each of the institutions requires an in-depth analysis of the situation. Paper-based or computer-based the tests rely on an established administrative and testing programme and academic and student participation.

The following section explores the results of a survey, which reviewed 13 departments in-depth using diagnostic testing. A small Working Group developed questionnaires for staff and student. The results can be seen in the section "*Diagnostic Testing within Institutions*", providing a collection of institutional approaches to diagnostic testing.

## An In-depth Study of Diagnostic Testing

At the Undergraduate Mathematics Teaching Conference 2001 a small Working Group was given a remit to consider what action is needed in higher education with respect to diagnostic testing of the mathematics skills of students starting degrees in which mathematics forms a major part; and to survey institutional follow up support. The Working Group was given financial support by a grant from the LTSN Maths, Stats & OR Network. What follows is an account of the work so far and in particular the responses to a survey of academic staff.

Lawson, Halpin & Croft [2], have already listed strategies that institutions might undertake to address the question of what action to take following the diagnostic test. The aim of the Working Group has been to concentrate on that part of their strategy which uses the results of the diagnostic test to specify extra support units for individual students. The survey has examined a sample of 15 of those which provide both diagnostic testing and follow-up support, and those which provide testing without follow-up support, noting both paper and computer-based tests and follow-up. Visits have been made to 13 of these institutions; each visit has included the completion of questionnaires by randomly selected students, as well as the completion of a second questionnaire by the member of staff responsible for the diagnostic testing.

The institutions visited have been chosen due to their target intake and to cover a variety of testing and follow-up procedures in the present survey. The types of degree covered vary from those which are largely mathematical to those in which mathematics is a subsidiary subject, e.g. for engineering. So far the survey has illustrated a wide variety of practice, even between institutions that appear in other respects to be relatively similar.

The detailed study was carried out in September/October 2002 during which time the institutional diagnostic testing was taking place. The testing procedures were observed by on-site visits and questionnaires. A large amount of data was collected which is still being analysed. Nevertheless the results already show some very interesting results (see Table 2). In particular note the number of institutions who have invested in writing their own diagnostic test and those who would use a national test if it were made available. It is evident that although many institutions do provide support for students who perform poorly on a diagnostic test, this is usually staff intensive and that as yet the use of CAL in this area is not widely supported. Finally, the apparent decline in student performance is as might be expected but the awareness of academic staff of what to expect from students is of concern. The final report will be available from the LTSN MathsTEAM website.

Questions	% yes
Did the institution write its own diagnostic test?	77%
If a national computer-based test were made available would you use it?	67%
Have deficiencies in mathematics worsened over recent years?	86%
Are there any dedicated support facilities available, "walk in" centres, etc?	67%
Is any use made of CAL material for supporting students?	17%
How many academic staff are up to date with key issues at the school/university interface?	20%
Does a staff development programme exist to ensure staff are informed?	39%
Is there a need for national diagnostic testing?	73%
Would you use a national database of diagnostic questions?	73%
If a diagnostic environment were provided which automatically linked to self-study and support, would you use it?	85%
Should such an environment be offered to schools to help students prepare for university studies?	67%

**Table 2:** Sample responses from staff questionnaires

## Preliminary Recommendations

There is a general consensus of the need for some form of diagnostic testing of students' mathematical skills on entry to HE; there are a wide number of approaches all with substantial merit. Having investigated the responses from both staff and student questionnaires, the Working Group make the following preliminary recommendations.

### 1. Advise students of the diagnostic test and supply revision materials *before* arrival.

Advise students of the existence of a diagnostic test, and supply examples of the questions with admission information, and supply them with suitable revision materials [3,4]. It needs to be made clear that a diagnostic test is not summative, but a means of helping individual students to plan their learning using new techniques such as self managed learning.

### 2. Make sure the purpose of the diagnostic test is clearly defined.

Inform students as to what information is being sought and explain how the results will be used by staff and individual students.

### 3. Provide follow up and support.

Have a clear strategy for remediation; provide support materials and a mechanism whereby students can assess their progress. (This could simply be a repeated attempt at the diagnostic test). Publish cohort results to enable peer reflection on performance.

## National Diagnostic Testing Survey

The project described above provided an in-depth analysis of certain institutional diagnostic procedures. The results were based on a cross-section of the total population of those departments using diagnostic testing. During 2002 - 2003 the LTSN MathsTEAM decided to conduct a national survey to try to obtain a more accurate picture of the number of institutions throughout the UK who are using diagnostic testing.

Each of the MathsTEAM members (LTSN Maths, Stats & OR Network, LTSN Engineering, LTSN Physical Sciences and the UK Centre for Materials Education) sent out the questions to departmental contacts. A review of the numerical results on a question-by-question basis is provided below.

### The Questions

The physical science, materials, maths and engineering communities were asked the following questions to collate a snapshot of the current situation of diagnostic testing in the UK:

- *Do you use diagnostic testing to assess student preparedness/ability/knowledge?*
- *If a test is used then is it: paper-based or computer-based?*
- *If computer-based, which package?*
- *In what way are the results of the test used or followed up?*
- *Does your department prepare fresher students prior to their arrival at university with regard to their mathematical skills, or general skills?*
- *If a tried and tested diagnostic test was made available and its delivery adapted to your needs, would you be interested?*

In addition academics in the LTSN Maths, Stats & OR Network were asked the following specific questions:

- *Do you teach students whose degrees are principally mathematics or is the mathematics for support teaching?*
- *With respect to service teaching, please list which departments or subjects you are service teaching for.*

There was also one question specific to the physical science and materials communities:

- *Does your department conduct mathematics teaching?*

## Analysis of Questions

### *Do you use diagnostic testing to assess student preparedness/ability/knowledge?*

	Percentage
Yes	68%
No	26%
(blank)	5%
Some	1%

68% of responders do use diagnostic testing of some kind to assess student preparedness/ability/knowledge. The extent and nature of the use of diagnostic testing does vary amongst institutions and different methods are often used for different courses.

### *If a test is used then is it: paper-based or computer-based?*

Of those that use diagnostic testing of some kind, paper-based testing is the most common. Some departments use both computer and paper-based tests, often for different courses.

	Percentage
Paper	64%
Computer	28%
Both	8%

### *If computer-based, which package?*

In-house computer packages appear to be the most popular diagnostic approach. DIAGNOSYS and Mathletics are the most popular of the question banks and Question Mark the most popular authoring package.

Computer Packages	Responses
In-house	9
DIAGNOSYS	7
Question Mark Perception	4
Mathletics	2
AIM	1
CALMAT	1
Maple/Mathematica	1
Teach & Learn	1
THINKS	1
WebCT	1

### *In what way are the results of the test used or followed up?*

Approximately 70% of responders provided feedback. Of those that did, only 2 respondents indicated that nothing was done with the results. In the majority of cases the results were used to determine the level of help for the students and the results were either provided as feedback to students, provided to tutors for monitoring, or used to determine how the course syllabus would be taught.

The most common methods of follow up are:

- Maths surgeries
- Extra tutorials

Other uses include:

- Advice to use self-help software
- Monitoring
- Provision of recommended texts
- Advice on alternative course/modules

### *Does your department prepare first year students prior to their arrival at university with regard to their mathematical skills, or general skills?*

	Percentage
No	41%
Yes	27%
(blank)	27%
Some	5%

27% indicated that their students are given preparatory material, however 41% of the respondents indicated that students are not prepared prior to arrival at university. Of those that do receive assistance the extent of the preparation varies and is often only available to certain courses.

Preparation material used includes:

- Booklets including in-house revision booklets
- Algebra and Calculus Refresher Booklet from the LTSN Maths, Stats & OR Network
- Small test for feedback at interview
- List of course topics
- Summer school
- Worksheets
- Anonymous tests

### *If a tried and tested diagnostic test was made available and its delivery adapted to your needs, would you be interested?*

- 72% of all responders indicated a positive response.
- 49% of respondents indicated that they would be interested and a further 23% indicated that they possibly may be interested.
- 18% said that they would not be interested.

The reasons for this disinterest include:

- Already happy with current software.
- Happy with simple in house system which has been in place for years which allows for monitoring.

**Do you teach students whose degrees are principally mathematics or is the mathematics for support teaching?**  
LTSN Maths, Stats & OR Network only

The majority of respondents from the LTSN Maths, Stats & OR Network provide both mathematics and support teaching.

	Total	Percentage
Both	39	62%
Maths	11	18%
Support	9	14%
(blank)	4	6%

**With respect to service teaching, please list which departments or subjects you are service teaching for?**  
LTSN Maths, Stats & OR Network only

The departments/subjects varied considerably with 63 different responses including the expected scientific and business type disciplines and the not so common such as art and design and nursing.

In summary the top 15 serviced departments/subjects are:

Department/Subject	Responses
Engineering	25
Computing	22
Business	14
Physics	14
Chemistry	12
Biology	8
Economics	7
Science	7
Environmental	6
Psychology	6
Business School	5
Applied Science	4
Geology	4
Health and Community Studies	4
Management	4

**Does your department conduct mathematics teaching?**  
Physical Sciences/Materials only

87% of the responses from Physical Sciences/Material Education departments conduct mathematics teaching of some kind.

	Total	Percentage
Yes	26	87%
No	3	10%
Some	1	3%

## Conclusion

Diagnostic testing provides a positive approach to a situation. For the student it provides a constructive method, which leads to ongoing support, and for the academic it is an indication of "what is needed" in terms of teaching and curriculum changes.

As the number of institutions implementing these tests increases it is becoming an integral part of mathematical education for first year students.

## References

- [1] *Measuring the Mathematics Problem*, Engineering Council, June 2000.
- [2] *After The Diagnostic Test – what next?* Interim Report of a Maths Project Funded by the LTSN Maths, Stats & OR Network, 1(3), Lawson, D., Halpin, M., and Croft, A., August (2001).
- [3] *Algebra Refresher*, LTSN Maths, Stats & OR Network, October 2001.
- [4] *Calculus Refresher*, LTSN Maths, Stats & OR Network, May 2002.