



SMEC 2012

Science and Mathematics
Education Conference

ESTABLISH | SMEC 2012

Teaching at the heart of learning

Dublin City University, Ireland
7th - 9th June 2012

Hosted by the
Centre for the Advancement of Science and Mathematics Teaching and Learning



APPROPRIATE SETTINGS AND SUPPORTS FOR THIRD-LEVEL DIAGNOSTIC TESTING IN MATHEMATICS

Eabhnat Ní Fhloinn^{1,2}, Ciarán Mac An Bhaird³, Brien Nolan^{1,2}

¹ CASTeL, Dublin City University, Ireland.

² School of Mathematical Sciences, Dublin City University, Ireland.

³ Dept of Mathematics and Statistics, National University of Ireland, Maynooth, Ireland.

Mathematical diagnostic tests are issued to first year students by many third level institutions, including Dublin City University and the National University of Ireland Maynooth. The aim of such tests is to provide staff and students with an immediate picture of which mathematical concepts are well-known to the student. The tests are also a mechanism through which students who are struggling are made immediately aware of a wide range of follow-up initiatives, which are provided by the respective Mathematics Learning Support Centres. A common questionnaire was issued to students in both institutions to ascertain their attitudes towards diagnostic testing. In this paper, we present an overview of the role of the diagnostic test in both institutions, look at the mathematical backgrounds of the students tested, and present their views on the purpose of the test and the environment in which they took it. We also investigate their views on the subsequent feedback they received and the supports available to them. Finally, we look at the changes that both institutions have made as a result of this questionnaire.

INTRODUCTION

The activities and entities collectively described as *mathematics support* now comprise a mature feature of the third level landscape both internationally and within Ireland (Gill et al., 2008, Perkin & Croft, 2004). The concept of providing additional support in mathematics to third level students has arisen in response to a well-established and evidence-based recognition of the mathematical under-preparedness of new undergraduates (Gill & O'Donoghue, 2007, OECD, 2003). In both Dublin City University (DCU) and the National University of Ireland Maynooth (NUIM), as is the case in many other institutions, mathematics support is coordinated by a dedicated unit: the Maths Learning Centre (MLC) in DCU (<http://www4.dcu.ie/maths/mlc/index.shtml>) and the Mathematics Support Centre (MSC) in NUIM (<http://supportcentre.maths.nuim.ie/>).

Many universities have adopted a policy of issuing diagnostic tests in mathematics to incoming first year students to identify (for both staff and students) the areas of main weakness. Considerable research is available on the provision of diagnostic tests, e.g. Ní Fhloinn (2009) and Gillard et al. (2010). This testing policy is a means to an end:

Diagnostic testing should be seen as part of a two-stage process. Prompt and effective follow-up is essential to deal with both individual weaknesses and those of the whole cohort. (Savage *et al*, 2000; p. iii)

Thus in both DCU and NUIM, diagnostic testing is followed-up by the provision of extra support mechanisms delivered early in the academic year by the mathematics support centres. Students identified by the test as being at-risk of failing their mathematics courses are encouraged in different ways to avail of this additional support. In DCU students are advised to attend refresher sessions on basic mathematics during the first two weeks of semester and to make frequent use of the MLC during the year. In NUIM students are assigned to an online mathematics proficiency course and accompanying

workshop. They are also encouraged to avail of the MSC as regularly as they can. The impact that these supports can have on students is well documented, *e.g.* Dowling and Nolan (2006), Pell and Croft (2008), Mac an Bhaird *et al* (2009) and Lee *et al* (2007).

Given the significant investment of time and resources in diagnostic testing and the associated follow-up activities, it is important to gauge the effectiveness of this approach. Key aspects of this effectiveness relate to students' attitudes to testing and follow-up. Thus with a view to building up an accurate picture of these attitudes, a common questionnaire was issued to first year DCU and NUIM students midway through the first semester in the academic year 2009-10. We report here on two aspects of students' attitudes, opinions and knowledge of the diagnostic testing and the follow-up supports. We consider the questionnaire responses relating to the following issues:

- What opinions do students have in relation to practical aspects of the implementation of the diagnostic test (timing, location, announcement of the test)?
- What views do students have on the additional supports provided following the diagnostic test?

These are important questions for staff involved in the provision of mathematics support. In this paper, we will describe the structure and delivery of the questionnaire and we provide a brief profile of the students who completed the questionnaire. We then present the results relating to the two research questions above, and give our conclusions about these results. Other aspects of the questionnaire responses will be reported on elsewhere, including the basics of student opinion on diagnostic testing – is it a good idea? – and student opinion on the overall feedback and related follow-up mechanisms (Ní Fhloinn *et al*, 2012).

METHODOLOGY

The questionnaire we report on was devised by members of the Irish Mathematics Learning Support Network committee (the first two authors and Dr Olivia Fitzmaurice (née Gill)). (See <http://supportcentre.maths.nuim.ie/mathsnetwork/>). The survey was anonymous, and comprised of 20 questions. The first seven questions relate to the profile of the student respondent and the remaining questions relate to opinion of diagnostic testing and follow-up.

The questionnaire was issued to first-year students in DCU and NUIM midway through the first semester of 2009/10. In DCU, the questionnaire was issued in paper-based form during mathematics lectures, resulting in 663 responses. In NUIM, the questionnaire was issued online via Moodle, resulting in 205 responses. Two paper-based questionnaires had already been issued in class to this first year cohort and it was not possible to get further class time to issue an additional questionnaire. The authors are aware of the restrictions of issuing an online questionnaire, and that the respondents may not be from a representative sample of the students who sat the diagnostic test. However, as we will see, the results from the online questionnaire are by and large very similar to the paper-based feedback, so we feel that their inclusion is valid. Where differences arose, they will be discussed.

RESULTS

Profiling questions

For completeness, we briefly review the first seven (profiling) questions on the questionnaire. These asked students to indicate their degree programme (Q1), mathematics module (Q2), gender (Q3), leaving certificate level (Q4) and result (Q5) in

mathematics, the time at which they switched from Higher Level mathematics to Ordinary Level in Leaving Certificate (if they did so) (Q6) and whether or not they were a mature student (Q7).

Respondents from DCU came from a large variety of programmes in business, computing, education, engineering and science, studying one of five different mathematics modules. Respondents from NUIM were studying (at least) one of four different modules and came from two different programmes, mathematical studies in arts and finance, and mathematics for science. There were 867 respondents in total (414 female, 451 male; 2 did not indicate their gender). 53 respondents identified themselves as mature students. 363 students responded that they took higher level mathematics at Leaving Certificate, 469 took Ordinary Level, 20 students responded 'other' to this question and 13 students did not respond. Students who started Higher Level Mathematics for Leaving Certificate and changed to Ordinary Level were asked to indicate when they changed. 93 Stated before Christmas in fifth year, 54 before the end of fifth year, 99 before Christmas in sixth year and 76 after the mock exams in sixth year. We will not consider results or level selection further here.

Opinion questions

The remaining questions (8-20) focused on students' opinion of certain important aspects of the diagnostic test itself. In this section we report specifically on the questions which consider the test setting, the length and timing of the test, and the feedback and supports made available after the test.

We were interested in whether students thought that the venue played an important role in the test. Students were asked if they felt that the room where they took the test was suitable. In DCU, the diagnostic test takes place during an introductory session to the MLC in Orientation Week. Although students are allocated a specific time to attend based on their class-group, a significant portion attend at an alternative time if it suits them better. This has led to overcrowding issues in some sessions. As a result, 24% of respondents in DCU did not feel that the room was entirely suitable, with students citing the lack of space and the large number of students present as negative factors, *e.g.*

No it was too small and people had to sit on the floor.

No, too many people in there - I couldn't really concentrate on the test.

By comparison, only 12% of respondents in NUIM (where the test took place during one of their mathematics lectures in week one) were not fully happy with the room, citing similar issues to those raised in DCU. However, the majority of responses concerning the venue were positive, *e.g.*

The atmosphere wasn't as serious because there were so many students and the room was so big. Which was a good thing.

Interestingly some comments, from both the positive and negative categories mentioned cheating, some saying that the venue made it easier to cheat (this was a negative comment), while others said it was harder to cheat (a positive comment). So, overall the venues used do not appear to have an unduly negative impact on students and indeed some students stated that the venue was not important.

General questions about the timing of the test and the length of time available were also asked. Students were asked if they felt that the timing of the test was suitable: 71% of the 713 responses were positive. Students in both institutions are not told in advance about the diagnostic test as we feel that this will give a much clearer picture of the material that is known or unknown to them. However, as the tests are not all conducted at the same

time for different modules, it is inevitable that some level of information about the test will emerge in advance. Despite this, 75% of respondents said they did not know about the test beforehand; 20% found out about the test from other students and 5% from a staff member. Students were also asked if they were given sufficient time to complete the test: 90% of respondents felt that they were.

One of the main reasons that both institutions issue diagnostic tests is to make students aware of the various supports that are in place should they need them. Students who obtain below a certain predetermined mark in the test are deemed to be “at-risk” and are advised to avail of various support mechanisms. It is made clear to them that this advice is based on their performance in the diagnostic test. Students were asked if they had been advised to avail of additional supports based on their results and 30% of respondents said that they had. 17 of 381 students in DCU and 32 of 126 students in NUIM who said they were *not* advised to seek support said that they did avail of some. However, in DCU only 60 out of 165 respondents who were advised to attend said that they actually did so while in NUIM this figure was 43 out of the 58 respondents advised. (We note that overall 291 DCU students and 224 NUIM students were advised to avail of support; not all of these students completed the survey.) This is one of the most concerning outcomes of this survey, and highlights a very important issue: how do we promote and maintain high levels of engagement in students who have been identified as needing to avail of mathematics support? Our interpretation of the difference in the respondents’ reporting of their uptake is that it relates to the difference in the mode of delivery of the survey in the two institutions: paper-based in DCU and online in NUIM.

Students were also asked to comment on the supports available to them after the diagnostic test. There were 367 comments and the breakdown is contained in Table 1. Responses were categorized as positive, negative, mixed, information comment and don’t know. *Positive comments* comprise those indicating a positive opinion on supports available to students after the diagnostic test; *negative comments* express a negative opinion. Responses categorized as *mixed* including both positive and negative opinions. Some students interpreted the question as asking for factual details about available supports: these comments described some of the supports available but gave no additional opinion and are categorized as *information comments*. A number of students responded *don’t know* or equivalent to the question and are categorized thus. These open-ended responses were categorized using the general inductive approach of Thomas (2006).

Table 1: Responses to Q16: “Please comment on the support available to students after the diagnostic test.” See text for description of the categories.

Response Category	DCU	NUIM
Positive	141	109
Negative	6	5
Mixed	6	-
Information Comment	95	8
Don’t Know	16	1
Total	264	123

THU 15.00 - 16.20

The majority (68%) of the 387 comments were positive which is very encouraging for both institutions. Considering all the responses, only 17 were *don't know's*, so most students (who responded) are clearly aware of the supports available. However this perspective must be tempered by the fact that 480 students (out of 867) did not respond to the question. Among the positive comments we find:

The support was huge after the test. people's confidence levels weren't high when we started our maths course, and even after the test. but as we all attended the maths support centre, and workshop, we could understand things a lot better and people are more able to work out the problems in their homework.

There is excellent help available to students through the support offered by the MLC.

The negative comments mostly referred to problems with the room where follow-up support sessions were held (too small), issues with tutors (e.g. not enough), timing of supports being unsuitable, or, in the case of a single NUIM student, problems with access to the online course.

Given that the respective student groups completed a common questionnaire, there is a surprising disparity between the proportion of DCU and NUIM students who gave an *information comment* response to the question. The information comments from DCU students seem to come principally from students who were not categorized as being at-risk and did not avail of support.

CONCLUSIONS

The main aim of the parts of the questionnaire presented in this paper was to determine if the diagnostic tests issued in both institutions are delivered in an appropriate manner, and if students feel that the follow up is sufficient. The majority of the feedback is positive and constructive, and this is very encouraging. In general, most students appear happy with the location, timing and lengths of the tests. This is consistent with the feedback we present in Ní Fhloinn et al. (2012) which shows that the students are typically very positive about diagnostic testing, its purpose and the potential benefit for both staff and students. This complementary study also shows that students have a good level of knowledge of the purposes of diagnostic test.

The evidence here also confirms that the supports available in both institutions are well advertised and known to the students who responded. This would suggest that the issuing of a diagnostic test to identify areas of weakness and to promote the supports in place works. However, it is also clear that a significant number of students who were advised to avail of support do not do so. This is a well documented concern which is reported elsewhere, e.g. Mac an Bhaird et al. (2009) and Pell and Croft (2008). This raises the question of how institutions can increase the engagement levels of 'at-risk' students with non-compulsory supports that are in place and that we know can benefit them. This issue is captured very well by the following comment from a student:

The supports are there, it is up to the student to avail of them. I feel at a disadvantage as it is so long since I sat the leaving cert, so maybe I push myself that little bit more.

One possible method is to introduce a monitoring scheme as described in Burke et al. (2012). This scheme was introduced in 2010-11 in NUIM, and students who were not showing appropriate levels of engagement were contacted and advised to change their behaviour. The engagement levels of the students contacted increased significantly.

REFERENCES

- Burke, G., Mac an Bhaird, C. & O'Shea, A. (2012). The Impact of a Monitoring Scheme on Engagement in an Online Course. *Teaching Mathematics and Its Applications: International Journal of the IMA*, to appear.
- Dowling, D. & Nolan, B. (2006) *Measuring the effectiveness of a maths learning centre, The Dublin City University experience*. Proceedings of the CETL MSOR Conference 2006, 51-54.
- Gill, O., Johnson, P. & O'Donoghue, J. (2008) An Audit of Mathematics Support in Irish Third Level Institutions. CEMTL: University of Limerick.
- Gill, O. & O'Donoghue, J. (2007). *The mathematical deficiencies of students entering third level: An item by item analysis of student diagnostic tests*. In S. Close, D. Corcoran & T. Dooley (Eds.), Proceedings of Second National Conference on Research in Mathematics Education (MEI2) (pp. 228-239), St. Patrick's College, Dublin.
- Gillard, J., Levi, M., & Wilson, R. (2010) *Diagnostic testing at UK Universities: an email survey*. Teaching Mathematics and its Applications, 29, 69-73.
- Lee, S., Harrison, M., Pell, G., & Robinson, C. (2008). *Predicting performance of first year engineering students and the importance of assessment tools therein*. Engineering Education: Journal of the Higher Education Academy Engineering Subject Academy, 3 (1), 44-51.
- LTSN MathsTEAM (2003). *Diagnostic Testing for Mathematics*. Accessed via http://www.mathstore.ac.uk/mathsteam/packs/diagnostic_test.pdf. (26th April 2012).
- Ní Fhloinn, E. (2009). *Diagnostic Testing in DCU – A Five-Year Review*. In Proceedings of Third National Conference on Research in Mathematics Education (MEI3) (pp 367-378), St. Patrick's College, Dublin.
- Ní Fhloinn, E., Mac an Bhaird, C. and Nolan, B (2012). *Students' Perspectives on Diagnostic Testing*. In preparation.
- Organisation for Economic Co-operation and Development (OECD). (2003). Learning for Tomorrow's World – First Results from PISA 2003. Paris, OECD.
- Pell, G. & Croft, T. (2008). *Mathematics support – support for all?* Teaching Mathematics and its Applications, 27, 167-173.
- Perkin, G. & Croft, T. (2004). *Mathematics Support Centres-the extent of current provision*. MSOR Connections 4(2), 14-18.
- Savage, M., Kitchen, A., Sutherland, R. & Porkess, R. (2000). In: Hawkes, T. & Savage, S. (Eds.), *Measuring the Mathematics Problem*. London: Engineering Council.
- Thomas, D.R. (2006) *A General Inductive Approach for Analyzing Qualitative Evaluation Data* American Journal of Evaluation, 27, 237-246.