Encouraging preparedness for first-year subjects involving quantitative concepts and skills

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Abstract

Students often come into university studies under-prepared for the quantitative aspects of their courses. A Murdoch University initiative in 2011 was to integrate access to diagnostic testing with student enrolment. At the point of enrolment, students enrolling in designated units were invited to check their mathematical skills through an online diagnostic quiz. The quiz provided immediate feedback on their performance and, depending on the quiz score, gave advice on enrolment in a tailored bridging program. This program consists of a series of modules from which students can select those appropriate to their needs.

Background

A lot of focus is being placed on strategies for enhancing student engagement, to increase retention rates and reduce failure rates in mathematics and statistics units. While much work has been carried out to try to establish a useful link between mathematics diagnostic exercises and success or failure in mathematics units (Carmody, Godfrey & Wood, 2006), or even how to ensure students are entering mathematics programs at the correct level (Britton, Daners & Stewart, 2007), the focus of this initiative is on how to prepare students for not only mathematics or statistics courses, but also for other courses with mathematical content. This is a step towards a whole of institution approach to the first year experience as advocated by Kift, Nelson and Clarke (2010).

Taking heart from research that indicates that diagnostic tests can be useful in highlighting student under-preparedness for the mathematical content of the courses (Carmody et al., 2006) and in an effort to make learning support in mathematics and statistics part of core university business (MacGillivray, 2008), we developed a diagnostic quiz to enable students to identify gaps in their mathematical knowledge. The quiz was provided in a context that informed students of, and encouraged them to use, the university's support programs before commencing their university studies. We hoped this would lead to early engagement by first year students and a more confident, self-motivated approach to their studies. The students would be alerted to the skills they needed and have a clearer understanding of the challenges of their university studies. More realistic expectations may help to reduce stress for the students, as noted by Scutter, Palmer, Luzeckyj, Burke da Silva and Brinkworth (2011).

Mathematics bridging programs are offered by many tertiary institutions. Some are provided to build on secondary mathematics studies in preparation for tertiary mathematics courses; others as a way to gain prerequisite knowledge in mathematics before attempting a mathematics course; and others again teach basic mathematical skills required for entry into a variety of fields. One of the major challenges for bridging maths programs identified by Gordon (2010) was to change students' perceptions of themselves as learners of mathematics. The Bridging Maths Program at Murdoch University was designed to encourage students to take responsibility for their mathematical learning and to seek help as needed.

Student diversity in background and motivation, and the brief time available for the programs before commencement of teaching semesters further complicate the effectiveness of such learning support programs. Student expectations of the university experience also come into play. Mature age entry students and school leavers have different needs and expectations of study and work commitments. Research indicates that early intervention programs to inform students of the realities of university life, and provide interaction with university teaching staff, may help with retention rates by initiating greater sense of academic and social inclusiveness (Brinkworth, McCann, Matthews & Nordström, 2009).

The diversity of contexts in which quantitative concepts and skills are required by university students is wide indeed. Thus, programs to underpin studies in subjects requiring mathematical skills may benefit a wide range of students. Science and engineering, business, politics, psychology, chiropractic, nursing and education, all require academic numeracy, that is, mathematics used in context, so that students can confidently interpret, critique and use mathematics in a variety of situations (Yatsukawa & Johnston, 1994, in Galligan & Taylor, 2005). Kemp (2005) has shown that students can develop academic numeracy through interpreting and reading tables, thereby gaining facility in statistical thinking. Mathematics and statistics service teaching at Murdoch University reaches students requiring academic numeracy in diverse disciplines, and we have addressed this need through the use of a diagnostic quiz linked to a mathematics bridging program tailored to discipline-specific requirements.

Problem context

Murdoch University students are characteristically not secondary school leavers. Around 70% of our students are mature age students, including those who have previously studied at other tertiary institutions. Our classes also include many international students and students studying off-campus in external mode. Our students come with varying levels of numeracy and experience with mathematical thinking.

Coordinators of scientific and quantitative courses had noted that their students were (i) nervous about the mathematical content of these units and often withdrew early in the semester, (ii) poorly equipped in numeracy skills and with little confidence in their mathematical abilities, and (iii) reluctant to enrol in their core mathematics and statistics units, often "putting off" these units until later in their degree programs.

In October 2010 a working group was formed between staff of the Student Learning Centre which offers learning support to students across the university and coordinators of Part I mathematics and statistics service teaching units (generally taken in first year of university studies). The working group wanted *numeracy* emphasis rather than *maths* emphasis, because the target was not mathematics students as such, but students from diverse disciplines who need maths concepts and skills and the ability to apply them confidently and successfully in their subject areas. The chosen means of achieving these goals was a diagnostic tool integrated into the standard enrolment process for all students, linked to a bridging program.

Maths diagnostic quiz (MDQ)

Since existing diagnostics appeared to be more oriented to mathematics students than to the numeracy skills required for quantitative courses, we developed our own form of Mathematics Diagnostic Quiz. As with all units at Murdoch University, the MDQ was set up on the Murdoch University Learning Management System, ready in December 2010 for students enrolling for Semester 1 2011.

The MDQ consists of numerical answer and multiple choice questions covering number concepts, formulae, numerical problems expressed in words, graphs, algebra, and statistics. All questions rely on concepts available to Year 10 mathematics students in Australian secondary schools. Students are advised to have a calculator with them. They are told the test will take about 30 minutes, and that there is no time limit (good students need about 15 min).

This diagnostic quiz is accessible to students enrolled in a range of first-year units with significant quantitative content: introductory statistics units for science and non-science streams, chemistry and physics units, mathematics and calculus units, and a chiropractic unit.

Information about the need for maths skills and the availability of the diagnostic is integrated into the enrolment process. Murdoch University students enrol online through a web interface. All students enrolling in the list of first-year quantitative units are automatically enrolled in a 'unit' that contains the MDQ. Messages about the MDQ are delivered as part of the enrolment process, and the MDQ appears in each student's list of units in the Learning Management System. In this way, students are prompted to consider if they are prepared for their studies in their quantitative unit and information about the MDQ is relatively unavoidable.

The MDQ is accessed through the same technology interface as all other online course content at Murdoch University. Language used on the introductory content page is inviting and non-threatening. Students are strongly encouraged, but not compelled, to do the MDQ. Messages to students emphasise preparation and assistance, rather than testing.

On completing the MDQ students are provided with a recommendation for action based on their score. The test is scored out of 50. Students who score less than 30 are advised to enrol in the Bridging Maths Program. Those who score between 30 and 40 are advised that they may be sufficiently prepared or confident, but their maths skills might benefit from a refresher course. Students scoring over 40 are advised that they most likely have sufficient maths skills for the unit they enrolled in, and do not need to take any further action.

Direct web links from the MDQ mean that students can enrol easily in the bridging program and/or seek further advice from staff at the Murdoch University Student Learning Centre.

Bridging maths program (BMP)

A bridging maths program has been offered at Murdoch University for over 5 years. In 2010 the Bridging Maths Program was redesigned by the Student Learning Centre numeracy support staff in consultation with interested unit coordinators. From 2011 the BMP is held over 4 days in Orientation Week, before formal classes commence. In its new form there are 8 modules (see table) covering the range of skills required for first year entry level mathematics, science and statistics units.

Students enrol online and do not have to come through the Maths Diagnostic Quiz online page. Some general advice about which modules relate to certain subjects was given on the Bridging Maths webpage: science degree students were advised to attend the full Bridging Program; statistics students were advised to attend "at least Modules 1 & 2 and 6 & 7", and so on.

Module 1 Numbers	Module 5 Algebra
Number line and kinds of numbers - Basic powers and	Symbols
square roots - Inequalities and intervals - Fractions,	Algebraic expressions - Algebraic fractions
decimals and percentages	Equations
Module 2 Computation	Module 6 Equations
Calculating with percentages, fractions, and decimals	Substituting in Formulas
Using powers and square roots	Rearranging formulas
Rounding - Word problems	Solving equations -Word problems
Module 3 Measurement	Module 7 Graphs
Powers of ten	Plotting points - Distance between points
Units of measurement and conversions	Linear functions
Scientific notation - Significant figures	Interpreting graphs
Module 4 Ratios	Module 8 Trigonometry
Rates - Using ratios	Angles: degrees and radians - Sine, cosine and tangent
Solving proportion - Word problems	Pythagoras' Theorem - Solving problems

The BMP is open to all Murdoch University students. It is made clear to students that the program is not compulsory and that they may enrol in any or all of the modules according to their course requirements or personal preference.

The week before Orientation Week 2011, Murdoch University First Year Experience Advisors (and some unit coordinators) sent emails to all first year students in the specified units, reminding them of and directing them to the MDQ. At Orientation activities, all new students across the university were given flyers advertising the free, short BMP and encouraging them to refresh their maths skills. The modules were held in two 90-minute sessions daily from Monday to Thursday in Orientation Week.

Preliminary results

Over 1500 students were enrolled in the MDQ online unit on the Learning Management System. Of these, approximately 36% attempted the quiz. Of those attempting it, 81% scored above 30 out of 50, leaving just over 100 students performing poorly on the quiz. Results to date do not indicate that students withdrew from their subjects if they performed poorly.

An increased number of students enrolled in the Murdoch University BMP than in previous years is an early sign of the usefulness of our approach. The mix of students from all parts of the university in the program has been encouraging. These students are now aware of the help and support available to them in their studies at Murdoch University and have connected with support staff. Presumably, those who did well on the quiz are left feeling confident in their abilities, understand that Murdoch University is concerned about their preparation and engagement with their studies, and are aware of support services available to them.

While the current diagnostic and bridging program were designed with internal students in mind, external students in remote locations have taken the MDQ and expressed definite interest in getting access to worksheet versions of the BMP material, and these are now available online with links to further resources. Externals will be explicitly catered for in future iterations of the program.

Conclusion

The Maths Diagnostic Quiz in Semester 1 2011 at Murdoch University is in a pilot stage, and evaluation will be largely qualitative, based on student interviews and our own learning from the organisational and teaching issues arising. We expect that by Semester 2 2011 the institutional framework will be more settled, some problems related to student

communication will have been addressed, and so take-up rates for the MDQ and the associated BMP will improve. This will allow quantitative analysis to be attempted, and we look forward to the contribution that will make to our learning about the preparedness of our students for success in subjects involving mathematical content at the first year tertiary level.

We hope to evaluate our Murdoch initiative in the next phase of the project in the light of the question raised by Galligan and Taylor (2008, p.15), "Are successful bridging maths students successful university students?"

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