Testing program reveals deficient mathematics for health science students commencing university

Teaching and Learning Forum 2013

Category: Refereed Research

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In response to staff concerns about literacy and numeracy standards of commencing students, the Faculty of Health Sciences at the University of Notre Dame Australia (UNDA) Fremantle campus, worked with academic support staff from the University's Academic Enabling and Support Centre (AESC) to develop a Post Entrance Numeracy Assessment (PENA). The PENA was designed to parallel and complement the University's Post Entrance Literacy Assessment (PELA) and to assess fundamental skills and knowledge in mathematics that should be acquired by years 9 and 10 at secondary school. The explored data highlight that significant numbers of students who embark on a Health Science course either had chosen not to study mathematics at year 11 or 12, or if they did choose a maths course, it was at Stage 1 or 2. For those students who studied Stage 1 or Stage 2 mathematics at high school, just 2/49 (4%) met the benchmark score of 65% in the PENA test. More concerning was that none of the 22 commencing students from a Certificate IV entry pathway achieved the benchmark score in the PENA. Therefore recent graduates from high school or colleges of Technical and Further Education (TAFE) display a significant deficiency in basic mathematical skills that are likely to hinder their performance in a Health Science course. Furthermore, we found that 21/29 (72%) students who were identified as below the benchmark score in PENA subsequently failed a semester long foundation mathematics unit. The results highlight that many Health Science students appear to be unaware of the pervasive nature of mathematical processes within their units and their course of study. A confounding issue regarding student support is that many Health Science students are reluctant to voluntarily attend academic support courses.

Keywords: health science, learning, mathematics, post entrance literacy assessment, post entrance numeracy assessment, secondary school, transition.

Introduction

The context of this study

The Curriculum Council of Western Australia recently segregated the study of secondary school mathematics into 3 category levels. Stage 1 and Stage 2 Mathematics were designed for students intending on a vocational educational training pathway. Mathematics 3AB is strongly recommended as a minimum requirement for those students who want to study science-based courses at university. The most challenging specialist mathematics courses are strongly recommended by tertiary institutions as a prerequisite for entry into science and technology-based disciplines such as engineering, mathematics and science. The health sciences incorporate a diverse range of disciplines including allied health specialisations in physiotherapy, occupational therapy, radiology, medical imaging, optometry, pharmacy, sports science, exercise physiology, biomedical sciences, health and physical education, health promotion and outdoor education. Given the breadth of scientific disciplines covered within the health science domain, each course requires that students learn and attain competency within discipline-specific mathematical skills that would be relevant for their future career. Competency in these skills would be evaluated through a variety of assessment formats within a unit, and the learning of higher order mathematics skills would be scaffolded across the course. Therefore given that mathematics is inherent across the health sciences we were interested in examining just how prepared were secondary students prepare to undertake tertiary study in a science based discipline.

During 2010, staff at the UNDA Fremantle Campus began experimenting with a *Post Entrance Numeracy Assessment* (PENA), in parallel with a *Post Entrance Literacy Assessment* (PELA); the latter has become increasingly common in Australian university settings (Murray, 2011). The first iteration of the PENA was a twenty question, multiple choice paper, completed in 20 minutes, without using a calculator, and designed to screen students who would be likely to have significant difficulties in mathematics. The results of the original PENA demonstrated that students were struggling with basic mathematical concepts from the time of entry. This was not a phenomenon restricted to Health Science students (with other entry cohorts tested for comparison data), nor this particular University, but part of a far wider Western Australian and national trend, demonstrated in a range of other research (Brown, 2009).

The purpose of the current study was to assess the mathematical competency of first year undergraduate students entering Health Science courses using a PENA test and to evaluate if the outcome of the PENA could be a reasonable predictor of student performance in a semester-long mathematics unit. Nearly twenty percent of the study cohort had no mathematics experience beyond year 10 or 11 at secondary school, and over half of the students who completed year 12 had studied mathematics at Stage 1 or 2. Students who had studied mathematics at secondary school to Stage 1 or 2, or who entered University from a Certificate IV pathway, were markedly below the benchmark score (of 65%) indicating they lacked fundamental skills in mathematics. Poor performance in the PENA test also correlated with poor performance in a first year mathematics unit. Therefore, the PENA test was able to successfully identify “at risk” students who are likely to struggle with units in their course where confidence and knowledge in basic mathematical skills are an important requirement. The results also highlight the important issue that universities need to be more explicit about the level of mathematics to be studied at secondary school in order to meet the prerequisite knowledge and skills required to study in a health science discipline.

Mathematical skills and concepts are pervasive throughout health science courses

Given that mathematics is essential for undergraduate success in the health sciences (Hall & Ponton, 2005; Koenig et al, 2012), there is a growing interest in identifying the prior knowledge that commencing undergraduate students have on entry. Traditionally, universities established compulsory prerequisite subjects which included specific standards of English, mathematics and sciences, related to their desired course of study. Increasingly, these prerequisites became ‘recommended’ subjects, and schools have responded by moving students away from more rigorous and demanding courses of study (Brown, 2009), to undertake less challenging courses. In doing so, however, many students begin their university studies without the necessary background and skills essential for success.

McNaught and Hoyne (2011) addressed the issue of students entering university not only lacking competence with more complex mathematics, but lacking skills with relatively rudimentary mathematics. Several factors were identified which had led to this predicament. Firstly, students were completing less rigorous mathematics courses at Years 11 and 12, and in many cases, taking no mathematics at all. Secondly, the mathematics (and science) courses in schools often demonstrated a complicit relationship between teacher and student, where students were covering the content that was specific to the final examinations, which would maximise the school and students' results, essentially ‘teaching to the test’ (Vogler & Burton, 2010). Thirdly, the generation of students arriving at this University appeared, based on the testing, to be ‘calculator dependent’; lacking mental mathematic skills, and the ability to reason and analyse without the use of technology. Only in recent times, have some school courses in Western Australia, included non-calculator sections within examinations.

In 2010, the University of Tasmania investigated the role of numeracy within all courses offered at their institution, noting the importance of mathematics and numeracy when both explicit and embedded (Skalicky, 2010). A large study performed in the United Kingdom found that low numeracy was more problematic for individual students, than low literacy: they are less likely to be successful in higher studies (Parsons & Bynner, 2005). In a program such as health sciences, a student’s achievement in their mathematics courses is a valid predictor of their overall performance within their degree (Hall & Ponton, 2005). Furthermore, Waycaster (2011) found that, in a study of five community colleges, success with mathematics courses was positively associated with student retention. Students who recognise the value of mathematics are more likely to be successful in their endeavours at tertiary study (Thomson & Hillman, 2010). Many health science entrants, however, appear to lack realistic expectations of the content, intellectual demand and academic rigour that is contained within a University course (Scutter et al, 2011).

Engaging health science students in mathematics support

Nationally, the students entering university have changed significantly, and student populations are more diverse than previous generations of entrants (Harris & Ashton, 2011). Chanock (2005) notes that *Academic Language and Learning* advisory staff have become an important part of the fabric of Universities, in response to the diverse needs and parameters of the cohorts entering (Chanock, 2005). Most *Academic Language and Learning* advisory staff, however, are involved in the delivery of literacy related content, rather than numeracy and mathematics. Academic support services have the potential to increase student retention whilst at the same time lifting academic standards (Peach, 2005). Whilst universities have a moral and ethical obligation to support students, the importance of adequately funding and providing these support services across the university could become a cost-neutral exercise over time if student numbers within courses are retained. If the lack of a mathematics background is likely to lead to attrition within the health sciences, the provision of additional courses could presumably bolster retention rates. Entrants may well expect this, with secondary schools, in directing students either away from mathematics subjects or into lower level courses, implying or stating that 'bridging units', commonly provided by universities, will enable them to acquire the necessary course-specific skills.

Health science students at UNDA are the least likely, of all cohorts, to engage with academic support services (McNaught & McIntyre, 2011). Thus, providing optional courses over the period 2009-2011 proved highly ineffective despite clear communication from staff. Students were provided with a range of options to attend courses and the careful marketing of such options. Data on access to student support demonstrate that Health Science students identified 'at risk' predominantly through PELA and PENA mechanisms, were the least likely to engage with support programs.

The reluctance of students to engage is made more complex with the subject material of mathematics. There are well recognised, commonly held, negative associations within the general population, towards mathematics (McNaught & McIntyre, 2011). It is considered socially odd to like mathematics and attracts an image of being an 'intellectual geek' (Ginsberg, 1997). This is the antithesis of psychological association for a talented sports person or physically active individuals, which are often found in health science programs. Mathematics is commonly perceived as the territory of the academic elite and a school subject to be endured by everyone else (Noss & Hoyles, 1996). It has become normal in Western societies to dislike mathematics, and odd to find it enjoyable (Ginsburg, 1997). Given the stereotypical view of mathematically capable individuals as socially inept and quirky (Mendick, 2005), support programs in this area present particular marketing challenges. Moreover, whilst literacy courses are able to teach specific skills (e.g. paraphrasing, essay structure), the linear nature of mathematics creates additional complexities, where the prior knowledge required may need to be taught (e.g. learning to calculate standard deviation requires other essential prior knowledge, which, if absent, needs to be covered) in addition to the actual content required. It is problematic that the most time-effective way of providing support is to focus on procedural mathematics, which is detrimental, as it reinforces poor teaching and learning experiences with the subject and positions the student to accept that a lack of understanding is acceptable, perhaps even desirable.

Profile of entering health science students

First year students entering courses in the School of Health Sciences at UNDA come from a range of academic backgrounds but all commencing students have to enrol in the foundation unit *CO115 Academic Research and Writing for the Health Sciences* which is where the PENA is delivered. The highest proportion of the commencing students in the 2011 semester 1 intake were high school leavers representing 58% of the total cohort that had obtained an Academic Tertiary Admissions Ranking (ATAR) score (Figure 1), while 15% of students had completed a Certificate IV course. Another 14% of students were mature-age entrants or students transferring from another institution and 5% met the minimal entry requirement by passing the Special Tertiary Admissions Test (STAT). The University offers a Tertiary Enabling Program (TEP) that supports secondary school students who failed to obtain a sufficient ATAR score to gain direct entry into a University course. The semester-long support program provides a bridging course with academic studies and students must obtain a distinction grade in the 7 units of study before they can be accepted into a Bachelor degree course. Ten percent of the starting cohort in 2011 were students who had completed the TEP program (Figure 1). The commencing cohort consisted of a ratio of nearly 2:1 females (62%) and males (38%).

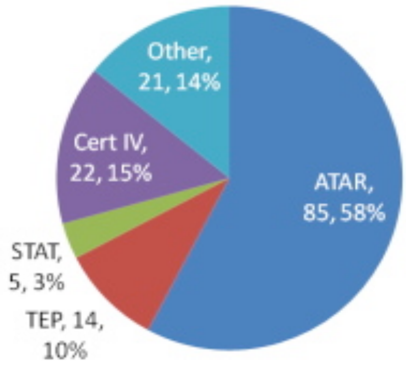


Figure 1: Demographic data for students entering health science courses at UNDA in Semester one 2011

PENA test results

There were 201 students enrolled in the CO115 unit in semester 1 2011 but only 165 students completed the PENA test. The PENA test (see Appendix 1) involved 10 questions that covered topics including metric conversion, algebra, proportions, probability, graphical interpretation of data, calculation of the area of a right angled triangle and determining combined averages. The students were given 20 minutes to complete the test and calculator use was not permitted. The test was designed to assess basic mathematical procedures that should be accomplished by year 9 - year 10 students at secondary school and the arbitrary benchmark score was set at 65%. The average mark for the test was 50% and notably 51% of the cohort failed to reach the benchmark score. In addition, students were asked to indicate the highest stage of mathematics they studied at secondary school. As noted in Figure 2, 18% of first year students entering Health Science courses at UNDA in 2011 had limited, or no mathematics experience beyond year 11 at secondary school.

Most students who entered the University via a secondary school entry pathway (n =85) had studied a mathematics subject at year 12 (82%) (Figure 2) but almost half of these students had only studied mathematics as a Stage 1 or Stage 2 subject (51%). Just 2/49 (4%) of the students who studied Stage 1 or Stage 2 mathematics met the benchmark score of 65% in the PENA test (Figure 3). These results highlight that the majority of students studying Stage 1 or Stage 2 mathematics at secondary school do not acquire or retain the knowledge of the fundamental numeracy skills by the time they leave secondary school. Equally concerning was the observation that just 6/19 (32%) of students who studied Mathematics 3AB at year 12 achieved the benchmark score of 65% (Figure 3). There were 9 students in the first year cohort who studied Mathematics 3CD at year 12 and 2/9 (22%) students failed to reach the benchmark (Figure 3).

Students who complete a Certificate IV meet the minimal University entry requirement for an undergraduate Bachelor degree course. In semester 1 2011, 15% of first year students entered Health Science Courses via the Certificate IV pathway. The data in Figure 4 highlight that none of the 17

Certificate IV students, irrespective of gender, achieved the benchmark score in the PENA test. These students are at a strong disadvantage with respect to their mathematics skills compared to students who complete year 12.

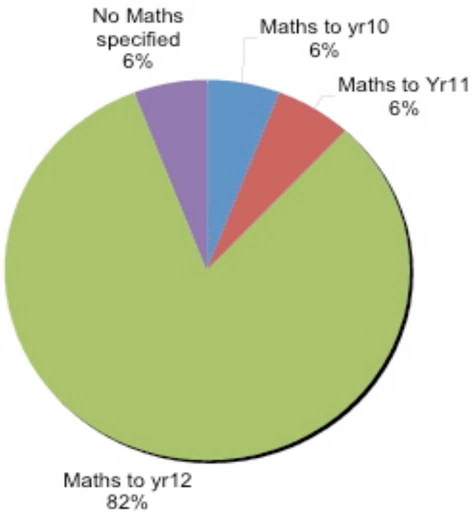


Figure 2: Information on the stage of mathematics studied at secondary school by first year health science students
(Data were collected from the PENA study with n = 165 students)

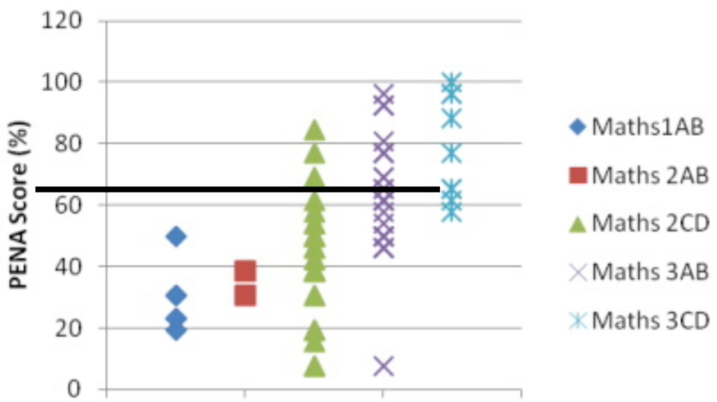


Figure 3: Comparison of PENA results with stage of secondary mathematics education. Each symbol represents the score obtained by a single student. The data were plotted for the number of students who studied Stage 1, Stage 2 or Stage 3 Mathematics. The solid line indicates the benchmark score of 65%.

Finally, analysis occurred to ascertain whether poor performance in the PENA would equate with a low final grade in a semester-long undergraduate mathematics unit. First year Health Science students can choose the *Foundation of Mathematics* unit, SM130, as an elective in their second semester, but enrolment in the unit is compulsory for students who had not completed Stage 3 mathematics at secondary school. The unit outcomes and the subject topics of the SM130 unit are outlined in Appendix 2. The unit is designed to reinforce mathematical concepts taught up to year 11 and 12 at secondary school. There were 19 students who enrolled in the SM130 unit in semester 2 2011 who had completed the PENA test in semester 1 2011. Only one student achieved the benchmark score in the PENA and completed the SM130 unit with a Pass Grade (a score of 52%). Of the remaining 18 students all had scored below the benchmark in the PENA and 16/18 students (89%) failed the unit (range of scores 10-42%), but there were two students who passed the SM130 unit with final grades of 50% and 54%.

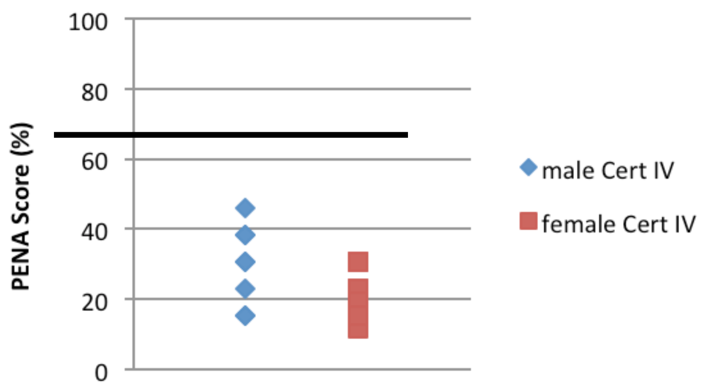


Figure 4: Comparison of PENA scores for male and female students entering via Certificate IV
The scores of n = 8 males and n = 9 females are shown.

There were 10 mid-year entry students who commenced their Health Science course in semester two 2011 who had completed the PENA test as part of their enrolment in the CO115 unit and were also enrolled in the SM130 unit. Of these 10 students only one achieved the benchmark score in the PENA and went on to achieve a pass grade in SM130 (score of 52%). There was 4/9 students who scored below the benchmark but managed to obtain a final pass grade in SM130 (range of scores: 50-66). The remaining 5 students failed the SM130 unit (range of scores: 10-44%). Thus taken together from a total of 29 students over two semesters, just 2/29 (7%) achieved the benchmark score in the PENA and managed to pass the SM130 unit. There were 21/29 (72%) who were below the benchmark score in PENA and subsequently failed the SM130 unit. There were 6/29 (21%) students who were below the benchmark score in the PENA but went onto pass the SM130 unit. Therefore taken together the PENA test could be used to predict reliably a student's mathematical ability and whether or not they would struggle with studying mathematics at a tertiary level.

Discussion

An undergraduate student entering a Health Science course at University could easily underestimate the requirements for mathematical competency since there may be few or any specific mathematics units to complete within their undergraduate degree course. In the Health Sciences however, mathematical skills are pervasive through a range of courses. In this study we have noted that a high proportion (~70%) of students who enter Health Sciences at UNDA do not have the necessary skills to perform basic mathematical procedures. A high proportion of students either chose not to study mathematics at secondary school, or chose lower stage mathematics units, presumably to maximise their ATAR score and guarantee that they met the minimal entry requirement for their chosen course. As demonstrated here through the performance in a PENA test, many such students who entered University are critically underprepared in terms of their mathematical skills for the academic demands of tertiary education. The PENA was a reliable predictor of student performance in a semester-long mathematics unit. The PENA could be used to identify "at risk" students at the start of the semester who are likely to perform poorly in compulsory units that require an innate capacity to perform basic mathematical procedures.

At UNDA, a Health Science undergraduate degree consists of 24-30 units of study that may include none, one or two mathematics units. Mathematics is however, an inherent part of many Health Science course. For example, in biomedical science units such as microbiology, biochemistry and physiology, students are required to carry out relatively complex mathematics, e.g. performing dilutions, calculating molarity, working with scientific notation and performing metric conversions. All these skills should be performed without the need for a calculator. Measurement of cell density is a more complex procedure that would require the help of a calculator. Biomechanics is a core unit within Exercise and Sports Science that requires a prerequisite knowledge of trigonometry and algebra as well principles of physics. To conduct fitness appraisals or to calculate an individual's body mass index requires a range of basic mathematical skills. In outdoor recreation, students may be required to calculate areas or volumes or to estimate distances for a specific trek. Likewise, a student in Preventive Health (Health Promotion) may be required to analyse demographic or statistical data. Helping students understand that mathematics is pervasive within all their units of study presents a significant problem for staff working with prospective Health Science students. Many express surprise that mathematics knowledge, skills and understandings are paramount to their course progress. Many of the skills, knowledge and concepts developed through upper school mathematics courses are not related to explicit numeracy outcomes. For example, mathematics courses develop analytical skills through problem solving and reasoning activities. They develop both deductive and inductive thinking skills. Therefore, much of the skill range that a student has from completing mathematics is not necessarily pure mathematics and remains broadly applicable to other learning areas in science.

Until recent years, universities established largely inflexible prerequisites as entry points into all courses of study. Traditionally, students who enrolled in a Bachelor of Biomedical Science at university would have completed a specified level of mathematics, and at least chemistry, as prerequisites for entry. This has changed dramatically in Australia, and the focus now is almost exclusively on a student's entry score, i.e. their ATAR ranking. It is understandable that schools focus students on maximising their ATAR score, and subject selections to achieve that goal, even if this is not in a student's best educational interests. For example, a 2012 UNDA entrant to the Bachelor of Exercise and Sport Science had an ATAR score of 87; however the student achieved this through a combination of courses in English, media, dance and geography. The student had completed no mathematics and no science courses through Years 11 and 12. Whilst the student had a high ATAR, she is likely to lack the prior knowledge that would be expected for a student entering the degree. We have noted from our demographic data collected at the time of enrolment that an increasing number of students that enter Health Science courses choose human biology without any other science unit at Year 11 and 12 at secondary school. Therefore, more students are avoiding the traditional mathematics and science subjects, such as physics and chemistry, at secondary school despite being destined for a career in a Health Science discipline.

Some universities have addressed the lack of prerequisites by having a list of 'recommended subjects'; this becomes problematic as there is no definitive requirement. Accordingly, a list of recommended subjects might alert a student that they will be advantaged by having such; however, it also implies that these subjects are not essential. Likewise, with many students unclear on their future study directions when they select their upper school courses, it may well be 'too late' to complete a recommended or required subject, regardless of the students' capacity to complete such. If students have been encouraged to undertake the subjects 'at the highest level' that they can manage, this is seldom a problem. It is a problem, however, in a model where schools attempt to have students maximise their ATAR score, by taking lower stage ('easier') courses to ensure high marks. For example, if a student is capable of completing chemistry but is dissuaded from doing so, and takes geography instead, it may well assist in terms of ATAR, but limit their course options or success in post-secondary schooling. Schools also inform students that universities offer short courses, or alternative units, to address a lack of prerequisites, as though this is a desirable option, rather than a fallback position. It is essential that UNDA establish prerequisites, and meaningful recommended subjects, in order to communicate clearly to secondary school students, that certain pathways are distinctly advantageous. Recognising that students might not appreciate the value of certain subjects to their degree (e.g. the importance of at least some mathematics to a health science course), better communication with future course entrants and to staff in secondary schools who regularly provide such information, is essential.

The University of Notre Dame's Fremantle campus, via the Academic Enabling and Support Centre (AESC) has created a range of short, intensive teaching focused, 'primer' courses, offered prior to the commencement of semester, predominantly for new incoming students. These courses include

- academic reading and writing
- mathematics

- information technology
- human biology

as well as specific courses for students who are entering from a mature-age background, and from a Certificate IV pathway. Whilst these primer courses are useful for a wide range of reasons, they are not a panacea for students having inadequate preparation through high school.

It is a particular concern that in the testing completed as part of the PENA in Semesters 1 and 2 of 2011, that students who had completed the relatively complex course of Mathematics 3AB, as determined by the Western Australian Curriculum Council, performed so poorly within what was essentially a simple mathematics test. It was not expected that a student who had completed a 'higher level' course (in this case Mathematics 3AB at Year 12) at secondary school would have demonstrated such inadequate skills and knowledge. Discussions with these students indicate that the use of calculators is a central issue, and whether there is appropriate division within the course between calculator and non-calculator content. Whilst there is clearly a place for the use of calculators with complex work, if a student cannot complete rudimentary calculations without a calculator, (e.g. working with proportions and fractions and the use of basic algebra) the issue warrants more extensive investigation.

Conclusion

Students entering Health Sciences at UNDA appear unaware of the pervasive nature of mathematical processes within their units and within their course; for students to be successful they must have an appropriate skill level. In secondary school, many students appear to choose the "softer" science-courses to avoid those 'mathematically laden' science-courses which demand higher level mathematics (for example, choosing human biology rather than chemistry). Universities need to be more explicit about the level of mathematics that is required in a diverse range of health science disciplines. As noted in this study, many of the students who enter university are critically underprepared and struggle with basic mathematics and this can set them up for poor performance in their course of study. Confounding this issue is that students are reluctant to seek academic support to improve their skill deficiency in mathematics. The UNDA PENA highlighted to students the importance of mathematics competency, and identified potentially "at risk" students. The data revealed that the PENA was a reliable predictor of student performance within a semester long mathematics unit. Given the large number of students who struggle with mathematics on entry, universities such as UNDA, need to provide academic support to improve skills; such support is essential for successful course completion and student retention.

References

Brown, G. (2009). *Review of education in mathematics, data science and quantitative disciplines*. Report to the Group of Eight Universities. http://www.go8.edu.au/__documents/go8-policy-analysis/2010/go8mathsreview.pdf

Chanock, K. (2005). The John Grierson Keynote: Critiquing and reflecting. In *Refereed Proceedings from the National Biennial Conference*, ANU, Canberra, pp. 11-19. http://aall.org.au/sites/default/files/las2005/chanock.pdf

Ginsburg, H. (1997). Mathematics learning disabilities: A view from developmental psychology. *Journal of Learning Disabilities, 30*(1), 20-33. http://dx.doi.org/10.1177/002221949703000102

Hall, J. & Ponton, M. (2005). Mathematics self-efficacy of college freshmen. *Journal of Developmental Education, 28*(3), 26-33.

Harris, A. & Ashton, J. (2011). Integrating academic and language skills within management units. In *Developing student skills for the next decade. Proceedings of the 20th Annual Teaching Learning Forum*, 1-2 February 2011. Perth: Edith Cowan University. http://otl.curtin.edu.au/professional_development/conferences/tlf/tlf2011/refereed/harris.html

Koenig, K., Schen, M., Edwards, M. & Bao, L. (2012). Addressing STEM retention through a scientific thought and methods course. *Journal of College Science Teaching*, 41(4), 23-29.

McNaught, K. & Hoyne, G. (2011). Mathematics for first year success. In *Proceedings of the 14th Pacific Rim First Year in Higher Education Conference*, 29 June-1 July, Fremantle. http://fyhe.com.au/past_papers/papers11/FYHE-2011/content/pdf/4F.pdf
McNaught, K. & McIntyre, F. (2011). When a pass is not a pass. *Journal of Academic Language and Learning, 5*(1), A100-A109. http://journal.aall.org.au/index.php/jall/article/download/126/97
Mendick, H. (2005). A beautiful myth? The gendering of being/doing 'good at maths'. *Gender and Education, 17*(2), 89-105. http://dx.doi.org/10.1080/0954025042000301465
Murray, N. (2011). University post-enrolment English language assessment: A consideration of the issues. *ERGO, 2*(1), 27-33. http://www.adelaide.edu.au/herga/ergo/0201/ergo_v2n1_p27-33.pdf
Noss, R. & Hoyles, C. (1996). *Windows on mathematical meanings: Learning cultures and computers*. Dordrecht: Kluwer.
Parsons, S. & Bynner, J. (2005). *Does numeracy matter more?* London: Institute of Education.
Peach, D. (2005). Ensuring student success - the role of support services in improving the quality of the student learning experience. *Studies in Learning, Evaluation, Innovation and Development, 2*(3), 1-15. http://sleid.cqu.edu.au/include/getdoc.php?id=336&article=69&mode=pdf
Scutter, S., Palmer, E., Luzeckyj, A., Burke da Silva, K. & Brinkworth, R. (2011). What do commencing undergraduate students expect from first year university? *The International Journal of the First Year in Higher Education*, 2(1), 8-20. https://fyhejournal.com/article/viewFile/54/80
Skalicky, J., Adam, A., Brown, N., Caney, A. & Lejda, A. (2010). *Tertiary numeracy enquiry*. Centre for the Advancement of Learning and Teaching (CALT), University of Tasmania. http://ecite.utas.edu.au/75821
Thomson, S. & Hillman, K. (2010). Against the odds: Influences on the post-school success of 'low performers'. Adelaide: National Centre for Vocational Education Research. http://www.ncver.edu.au/lsay_pubs/research/LSAY_2285.pdf
Vogler, K. & Burton, M. (2010). Mathematics teachers' instructional practices in an era of high-stakes testing. *School Science and Mathematics*, 110(5), 247-261. http://dx.doi.org/10.1111/j.1949-8594.2010.00032.x
Waycaster, P. (2001). Factors impacting success in community college developmental mathematics courses and subsequent courses. *Community College Journal of Research and Practice, 25*(5-6), 403-416. http://dx.doi.org/10.1080/106689201750192256

Please cite as: McNaught, K. & Hoyne, G. (2013). Testing program reveals deficient mathematics for health science students commencing university. In *Design, develop, evaluate: The core of the learning environment. Proceedings of the 22nd Annual Teaching Learning Forum*, 7-8 February 2013. Perth: Murdoch University. http://otl.curtin.edu.au/professional_development/conferences/tlf/tlf2013/refereed/mcnaught.html

Appendix 1: Unit outcomes for Foundation Mathematics Unit

Outcomes of the unit *SM130 Mathematics Foundation*

At the completion of this unit, a student will:

1. Have overcome the fear of mathematics and be more comfortable "doing" mathematics and problem solving
2. Have a deeper understanding and insight into basic ideas and methodologies
3. Have better understanding of "why mathematics" and how this translates into better teaching of mathematics (at any level)
4. Be better prepared with "long sight" of mathematics to anticipate and foster curiosity
5. Have meaningful vehicle for highlighting the process aspects of mathematics such as - specialising, generalising, detecting patterns and regularities, making and testing conjectures, estimating answers, searching for counter examples, proving results, communicating to others and summarising the main ideas of a mathematical argument
6. Have increased awareness of the task of integrating and applying mathematics into other disciplines
7. Have confidence and competence in using basic mathematics tools.

Topics include

Basic arithmetic
Scientific notation
Fractions – common / mixed fractions – representing fraction
Basic algebraic operations
Basic geometrical shapes
Ratio and proportion
Measurement of volume, surface area of sphere, cube cylinder
Basic trigonometry sine, cosine, tangents
Mathematical equations using trigonometric ratios
Graphs, plotting graphs in a Cartesian coordinate system, plotting linear equations

Appendix 2: Short Maths Test 1

1 Convert 20 000 000 mm into metres _______________

2 Convert 2.34567 litres into ml (millilitres)_______________

3 Add the fractions $\frac{2}{3} + \frac{3}{4}$ If the answer is greater than 1, write it as a mixed numeral.

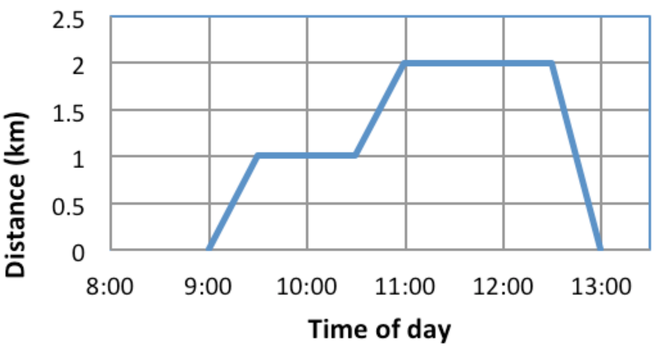
4 Find the value of x if 2(x + 3) – 9 = 7

5 Simplify, writing your answer as a whole number $2^3 \times 10^3 + 16 \times 10^4$

6 Alpha, Bravo and Charlie shared a bag of sweets. Alpha received $\frac{1}{4}$, Bravo received 40%. What % did Charlie receive?

7 Two normal dice are rolled. What is the probability that
a) the first die shows a 5 and the second die shows a 3?
b) the total on the two dice is 8?

8 The graph below shows how Jan's distance from home varied with time as she walked to her friend's house, stopping in at the shops on the way, and walked back home again.



How far is it from Jan's house to the shop? Answer: ________ kilometres
How far is it from Jan's house to her friend's? Answer: _______ kilometres
How long did Jan spend at the shops? Answer: ________ minutes
How long did Jan spend at her friend's house? Answer _______ minutes
How long did the trip take altogether? Your answer: _________hours

9 Find the area of a right-angled triangle with sides 15 cm, 12 cm, 9 cm

10 Echo group scored an average of 80 in a test. Foxtrot group scored an average of 90. There are 20 people in Echo and 30 in Foxtrot. What was the combined average of the two groups?