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Tertiary Students' Numeracy Skills Requirements

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Abstract

The following paper arises from the author being invited to be part of a discussion panel of NZ tertiary learning advisors, at a regional hui. The main topic was the numeracy skills required for our current students to be successful with their studies. The paper gives some background and context, then focuses on the actual skills that students bring with them. This moves onto thinking about strategies to deal with any perceived numeracy deficiencies, including online help, tutorials and workshops. It then outlines the learning advisor services and support we can offer students, and finishes with a discussion of the skills necessary for effective learning advising and content advising to take place.[1]

Keywords: numeracy, tertiary advising, learning advisor

Background and Context

At a recent Association of Tertiary Learning Advisors Aoetoaroa/New Zealand (ATLAANZ) Auckland Regional hui, numeracy was the main theme of the day and there was a panel discussion about this spearheaded by Advisors from a range of institutions and levels of service to students (University of Auckland, Unitec Institute of Technology, and Eastern Institute of Technology). The following discussion comes as result of the author's invitation to be on the panel and the thinking involved in preparation for this and the ensuing open conversation. At the end of each section is a list of issues that were raised, which are in some ways summaries of each section, and pose questions that are pertinent for all tertiary institutions to be considering at the moment.

We are all familiar with Bloom's taxonomy of learning domains and cognitive objectives relating to higher order thinking skills (HOTS) which everyone needs to survive (Bloom, 1956), and Krathwohl's (2002) revision of these such that 'knowledge' becomes a separate 'noun' category while the 6 cognitive processes are defined as the more active 'verb' categories; remember, understand, apply, analyse, evaluate and create. Bloom's taxonomy has been specifically interpreted into mathematical contexts (Shorser, n.d.) and more recently in the international Millennium Mathematics Project (Cambridge University, 2014) where the focus is on increasing mathematical understanding, confidence and enjoyment, enriching everyone's experience of mathematics, and promoting creative and imaginative approaches to maths (Piggott 1997-2012).

[1] Note: A different version of this is undergoing double blind peer review for the ATLAANZ Proceedings 2013.

Similarly, in recent years in New Zealand there has been an extension of numeracy to include multiple, open descriptions, concentrating more on how people make use of their skills and how they utilise different texts and modalities in a range of settings. Thomas (2008) describes how the '1996 International Adult Literacy Survey (IALS)…showed that numeracy could be a barrier to effective participation in society for up to 50 per cent of the New Zealand adult population' (p. 137). She continues to describe how numeracy was revised and re-defined by Gal, van Groenestijn, Manly, Schmitt, & Tout, (2005) as the 'knowledge and skills required to effectively manage the mathematical demands of diverse situations' (Thomas, 2008, p. 142). Another IALS sponsored by the OECD in 1997 showed New Zealand's results were largely similar to Australia and the United States, and that it represented adults from all groupings and sectors of society (Benseman, 2008, p. 17). New Zealand has also participated in further surveys during 2007.

Benseman states '[d]uring 2006 the government developed its second *Tertiary Education Strategy 2007-2012*' which 'highlighted areas of urgent action for the next 3 years, 'including (on p. 30 of this *Strategy*) "increasing the literacy and numeracy skills of the workforce" and "achieving educational success for young New Zealanders – more achieving qualifications at level 4 and above by age 25" as two of four national priorities.' (p. 18). The Tertiary Education Commission (TEC, 2008) states 'To work and participate effectively in a modern knowledge society, New Zealand adults require a certain level of numeracy expertise.' (p. 4), and the document goes on to describe how it provides a framework that shows what adult learners know and can do at successive points as they develop their expertise in numeracy learning. The numeracy progressions are organised according to three main threads: 'Make Sense of Number to Solve Problems, Reason Statistically, Measure and Interpret Shape and Space.' (p. 5). Each progression covers a particular aspect of learning and the framework can be used in three main ways: to gain a basic picture of a learner's current skills, strategies and knowledge; to identify the numeracy-related demands of specific workplace, community or personal tasks, problems and texts, and; as a source of sequences for teaching and learning programmes, with suggestions about designing these programmes. The progressions and advice are also for teachers to use as a basis for developing or adapting their own curricula, programmes, assessment tools, and teaching and learning activities. In this respect numeracy is viewed as a socio-cultural phenomenon, situating the adult learner within their community, wherever they may need to function in relation to online literacies as well as to critical numeracy for their work and daily lives.

Obviously it is important for teachers to be able to gauge where all their students sit on these various progressions so as to best tailor their classes to suit the current learner demographic. Whatever skills, understanding and learning maturity students bring with them to the classroom, and whatever particular mathematical prior knowledge and abilities they may have, will influence the course content from the teacher's perspective. From the students' perspective, their existing mathematics levels will also influence the rate and effectiveness of uptake of new material and concepts.

The Numeracy Skills Which Students Bring to Their Studies

For the most part, students currently coming to Unitec via regular secondary school years 12 and 13 seem to present with sufficient foundational (everyday) numeracy. In fact in 2013 about 70% of

students enrolled in Level 4 & 5 courses (Diploma and BA year 1) are on Step 5 and 6 of the Numeracy scale, as tested via the Learning Progressions. According to the Senior Lecturer working with Literacy & Numeracy within Unitec at the time, on the whole, these students appear to cope quite well with the numeracy demands of their course.

The main difficulties are experienced by students on either side of this spectrum i.e., at the lower level 3 (Certificate) courses such as Electro-technology and the higher undergraduate degree level courses which have high maths demands, such as Accounting and Engineering. The same also applies to some postgraduate programmes where students can struggle with the demands, such as Financial analysis and Statistics, and with a range of courses in Health & Social Sciences, which use quantitative research analysis methodologies. Nursing students also seem to have particular difficulties with proportional reasoning, medical calculations, calibrations and conversion of volumes etc.

Not only are numeracy requirements of the courses at Level 3 less than for the Level 4 & 5 courses, but there is also currently an open enrolment policy for these programmes, which are popular with, for example, Youth Guarantee Students. At the time of writing, these courses have no prerequisite level of maths understanding necessary for students to get enrolled in the course, so students presenting below Step 5 are going to be at a disadvantage.

A compulsory diagnostic test, which is required by the Ministry of Education, maps each student on the progressions. It is one way of determining the levels and future needs of these students, along with teacher observations of students' abilities in class and their course work. The diagnostic test can also help to highlight gaps in student knowledge and understanding, and so make it easier for the teachers to target them with appropriate tuition embedded within the programme. Alternatively these gaps could usefully be covered with mentoring by Peer Assisted Student Support (PASS) Leaders or by some form of assistance from learning services on campus. In Unitec's case this is the role of Te Puna Ako Learning Centre, where there are 2 specialist maths lecturers who are student advisors, covering all Unitec students. The types of courses being supported include Accounting, Law & Finance, Business, Engineering, Architecture, Trades (e.g. carpentry, joinery, boat building, plumbing, electrical, auto-electronics, mechanics etc.), Nursing, Veterinary science, IT and Computing, Sport, Osteopathy, Medical Imaging and Foundation, and Researchers.

Issues for institutions to consider:

1. Are students presenting with necessary numeracy skills required for their course?
2. What are the gaps?
3. In which disciplines?

Strategies to Deal a Lack of Numeracy Skills for Courses at Undergraduate and Postgraduate Level

When these questions have been addressed, and there is a perceived need to upgrade the numeracy skills of students within certain courses, our tertiary institute offers a range of strategies to try to meet the various needs of these students. These include online assistance, and also face to face support, via tutorial sessions and workshops.

Online Support

For independent online support, there is a DIY Maths site which is embedded within the Library Guides (http://libguides.unitec.ac.nz/DIYMATHS) that any student can access. This is well laid out for ease of navigation and with general topic heading tabs for: Using DIY Maths, Fractions, Decimals, Measurement, Trigonometry, Algebra, Data & Statistics, and Percents. If learners are studying a programme that requires competency in maths, the modules in DIY Maths can help them to refresh their skills or study new content. Within each of these topics are specific modules there are video lessons, content links, games, downloadable worksheets, practice quizzes, and links to maths tutors. Every module also provides search tips, so students can find their own information to supplement their learning[2].

Students can also access the Te Puna Ako website through their own logins and moodle, for both direct maths (virtual) assistance or to book in for a workshop with a lecturer. Besides this, academic development lecturers also offer online (email) assistance to some students as well, or some other form of eAdvising. Unitec is investigating the use of Skype, Adobe Connect and Google Groups for these purposes. The issue of 24/7 expectations from students and meetings of these needs may need to be addressed if more synchronous or timely advising is aimed for, as well as the issue of providing the necessary technological backup for these services to be reliable (maybe even from off-site).

Tutorial Sessions

There are some regular group tutorials run by Academic lecturers at Te Puna Ako, especially for nursing students (e.g., calibration calculations), for business statistics and for engineering calculations. At other times, more informal weekly 'drop-in' tutorials may be run for course-specific purposes e.g., a weekly tutorial before class for Certificate plumbing students, purely to go over maths problems related to their coursework and ensuing external exams. Unitec also offers one to one tutorials, both by appointment and on a 'drop in' basis.

[2] The site also lists other helpful sites such as: https://www.khanacademy.org/; http://www.mathsisfun.com/; http://www.mathwarehouse.com/calculators/; http://www.mathwarehouse.com/calculators/

Workshops

There are both timetabled workshops and on-demand workshops (if requested by students and/or staff), led by Te Puna Ako staff e.g., Applying your scientific calculator and Creating graphs in Excel. For postgraduate students there are also timetabled specialised workshops about Research design and sampling processes, Quantitative data analysis: Introduction to statistical concepts, Quantitative data analysis: Introduction to types of data and relationships; Qualitative data analysis – Maori Methodological perspectives, Interpreting and analysing qualitative data.

One of the challenges we all face as advisors is knowing if we are meeting the needs of all our students. What about those who do not chose to visit us? Why do they not visit us? We need to consider the activity and passivity of the advisory role, try to be ready for when the 'tyre hits the road'. We need to think about our role in terms of preparation and building up learners' skills before (or to avoid) the potential stresses that demands of study may make on them i.e. work from a strength-based model rather than working with a remedial or deficit model. Within we need to think about when this should be offered and implemented to encourage maximum effectiveness.

Issues for institutions to consider:

1. What role should learning advisors play?
2. When is intervention first required? i.e., prior to University for first years or the first year of University?

Learning Advisor Services/Support

At Unitec some specialist training workshops led by learning advisors are offered, to complement the 1 : 1 support, and depending on the situation, this can be either embedded and regular, or standalone. There are also some PASS tutors on various programmes who can also help students with their mathematical coursework, usually on a regular basis, e.g. once a week.

Embedded support is embraced by most of the lower level Trades courses at Unitec (e.g., CAMES – Automotive & Mechanical Engineering) as the teachers see their roles as instructing students in the practical side of the discipline as well as helping them to understand the numeracy used and how to use the technology required in a very practical way. Most of these students have not had successful or highly academic education to this point, so another approach is more beneficial for them. For some of them, being shown how to work out the calculations etc. via practical examples and in the context of their shop-floor or site work is easier for them to grasp. Also, there are some instances where the teachers know the discipline-specific applications better than academic support people e.g., in the field, plumbing calculations and materials are referred to in terms of diameter, rather than radius, which is the measurement used in more purely academic calculations of circumference and area.

Another approach taken by the Certificate of Business and Administration lecturers is to not actually use mathematical terminology much at all, avoiding the 'm'- word (maths!) altogether. Instead, students are shown for example "a method of how to work out out the GST that has to be paid" rather than a series of examples to teach them percentages and 'if-'statement sum formulae. This also serves to allay any inherent fears that students may have.

On the other hand, stand-alone support seems to work better for those disciplines which currently have a very strong deficit discourse such as the maths-rich engineering and accounting courses. The teachers on these courses expect students to present with the requisite knowledge base to understand and manipulate data they are given in class. If students have come through a pathway from school, industry or through the institute, the expectation is that the Foundation courses will have filled the gap(s) of this knowledge deficit before they come to class. Therefore it is for these types of classes that it works better to have either remedial block courses at Te Puna Ako or on-going tutorials so that students can get up to speed.

Also, of course, while the engineering lecturers, accounting lecturers etc. are specialised in their own discipline content area, they may not necessarily be qualified maths teachers or have the skills to do this. Alternatively, they may be able to use the theories and equations etc., but not necessarily know how they work and be able to impart this to the student if necessary as well. In 2008 Thomas was advocating improvements based on teacher development (Benseman & Sutton, 2008), and it still seems to be an appropriate comment today:

> "One of the next steps for improving numeracy achievement more generally within adult foundation learning is to investigate how the Adult Numeracy Initiative can be scaled up to efficiently and effectively support the varies professional learning needs of tutors working across a wide range of contexts. There also needs to be careful consideration given to ensuring that any professional learning translates into embedded and sustainable numeracy teaching practices that have a positive impact on learner achievement." (p. 141)

So there are several pedagogical and operational questions that institutions and advisors may need to address in terms of what learning skills teachers could or should include in their content teaching, and what is better taken on by specialist staff. Also, we need to think through what format might most useful to certain students, while at the same time meeting our institutional or departments financial restrictions in terms of time spent on group and individual sessions.

Issues for institutions to consider:

1. Are training workshops by learning advisors needed to complement face to face support?
2. If so, are these best offered as embedded support or stand-alone?
3. Related to this, where does the responsibility of faculty end and student learning centres begin?

Learning Advisor Skills

In accordance with the outcome of the above questions, we need to ensure that we have the requisite skill set and talent within the advisory staff. The need for up-skilling also depends somewhat on the demand from learners and the exigencies of the institute. As previously mentioned, Unitec's Te Puna Ako has two dedicated specialist maths advisors to meet the needs and cater for all of the students across three campuses. The third campus is relatively new and still growing so does not have regular maths specialists, which highlights the fact that to enable a physical presence on campus, it is necessary to have enough critical mass of student demand, so that a dedicated numeracy support lecturer can be profitably occupied. Economies of scale may then come into play – if there is a lot more maths advising activity being undertaken at the campus, so employing more and/or specialised more tutors is deemed worthwhile.

Whether up-skilling of Te Puna specialised staff is considered necessary is also a function of whether it is purely the content that needs to be taught (the expert knowledge that the course is based on), or general mathematical manipulation skills (i.e., a more generic component of the learning) or if it is in fact the ways dealing with this specific content knowledge, which may again be discipline-specific and therefore requiring a discipline lecturer to explain in more depth. e.g., financial analyses and plumbing pipe calculations, as already mentioned above.

Issues for institutions to consider:

1. Do general learning advisors need 'up-skilling' in particular areas of numeracy? e.g. first year finance, or does this need to be delivered by specialist numeracy learning advisors, (or the lecturers)?
2. If it is to be delivered by specialist numeracy advisors, will they need to be up-skilled in areas unfamiliar to them, such as engineering/ finance/ business/ accountancy/ quantitative research skills?

Role of Content Tutors

If it is determined that pure content is best delivered by Faculty teaching staff, while Academic Support focuses mainly on learning skills and strategies, academic literacies and academic writing, including referencing etc, then post-graduate peer support can be seen as a useful addition to the academic development/support range of offerings.

PASS Leaders

Unitec has for several years had a robust system involving the PASS Leaders, who are successful past students specially trained in facilitating the content learning and manipulation of numeracy elements

in lower level classes of the same subjects they are currently studying. These Leaders are selected by the Faculties and lecturers involved and paid by the Faculties involved. Research by Holland (2012) has shown the benefits of such personal mentors:

> "The impact that mentoring has on these young learners reminds us that human connection is central to the learning process. We know that mentoring can re-inspire an enthusiasm for learning and success. We also know that the cultural/community mentor model, with its special focus on Maori and Pasifika values and needs, is successful for such apprentices. Not only successful, but necessary. For low paid learners frequently blamed for poor productivity and performance at national and local levels, we need to keep improving mentoring models that build apprentices' confidence in themselves and show what they can contribute." (p. 46).

Issues for institutions to consider:

1. What role should content tutors (i.e. peer tutors) play, if any, in helping to teach and consolidate numeracy skills?
2. Are teachers having enough professional development opportunities to improve their numeracy teaching?

Nerves

During the hui, there were quite a few references to maths anxiety and how this may be alleviated. It was noted that women are generally disproportionately highly represented in maths tutorials and numeracy workshops at all levels, a factor that can be in part be supported by research suggesting "that motivational patterns may contribute to gender differences in mathematics achievement." (Dweck, 1986). Others in the audience commented that when teaching statistics in the past, it was noticeable that New Zealand young women appeared to have a lower level of maths awareness than their male counterparts – and certainly also have a much lower concept of their mathematical abilities.

Most of us understand that, while a little stress may be a good thing, prolonged or excessive stress can be very debilitating "…the positive side of the stress curve (…) actually enhances performance. However, when the anxiety gets out of control and crosses to the other side of the curve, performance plummets." (Tennant, 2005). We also recognise what research suggests, i.e., "that stress can block chemical reactions in the brain that are necessary for learning. Stress can disrupt learning and memory development (long-term potentiation (LTP)) as it forces the brain to revert to more primitive survival needs." (The Training Place, 2007-12). What may also be surprising is though, that "Although it is known that long-term or chronic stress can affect the brain's learning and memory region, a new finding discovers short-term stress, lasting as little as a few hours, can also impair brain-cell communication in these critical areas." (Grohol, 2008).

An appropriate way to allay this inherent anxiety was described above (not using the 'm' word), and also rephrasing maths problems in very practical terms, both for CBAC and the Trades courses, was thought to be a suitable approach. Besides this, our students can be assisted to become more confident by illustrating to them that they can in fact perform some maths functions very well (e.g., by using a real-life situation whereby students have to work out the cost of shirts discounted in a sale by 50%). On the other hand, it was also noted that whereas it is socially not acceptable to admit to literacy problems, it is much more readily socially acceptable to admit to maths problems without much stigma being attached to this, if any. Indeed, it may even be regarded as quite normal.

Issues for institutions to consider:

1. What strategies can be put in place to reduce maths anxiety amongst students?

Future Research/Investigation

Numeracy Plotting

Most advisors continue to strive to provide services to all their students "Before, Beside and Within" their classes and studies. An interesting future project could be to undertake a comprehensive survey of the courses offered at the institution, and highlight the numeracy needs and skills areas required to be able to successfully start on the course. Then another survey of the expected learning outcomes could determine the skill set expected by the end of the course, and map all of these against the level of students' numeracy (as described in the Learning Progressions), cross-referenced against the explicitly and/or implicitly documented requirements of the numeracy skills dictated by the course

This paper sets the context for the professional peer-conversations held at the ATLAANZ regional hui. It bases the discussion within the context of past research, and investigates the pedagogical considerations and social context of our tertiary level learners and their various individual numeracy needs. Of course there are always financial imperatives and institutional philosophies around the role of the advisor and the learners involved, and this paper attempts in part to outline how these are applicable to tertiary educators, particularly at Unitec. The essence of these is included in the lists of *Issues for institutions to consider* after each section, which serve as a form of summary, highlighting the matters raised by the group of like-minded colleagues.

References

Benseman, J. (2008). Foundation learning in New Zealand: An overview [Chap 1]. In J. Benseman & A. Sutton (2008). *Facing the Challenge: Foundation learning for adults in Aotearoa New Zealand.* Dunmore Publishing Ltd: Wellington.

Bloom, B. S. (Ed.). (1956). *A Taxonomy of Educational Objectives.* New York: Longman.

Dweck, S. (1986). Motivational processes affecting learning. Retrieved from http://psycnet.apa.org/psycinfo/1987-08696-001

Gal, I., van Groenestijn, M., Manly, M., Schmitt, M.J. & Tout, D. (2005). Adult numeracy and its assessment in the ALL survey: A conceptual framework and pilot results. In S.T. Murray, Y. Clermont & M. Blinkley (Eds.). *Measuring adult literacy and life skills: New frameworks for assessment (*pp. 137-191). Ottawa, Canada: Statistics Canada. Quoted by Thomas, G. (2008).

Grohol, G. M. (2008). Stress Affects Learning and Memory. [Review]. Retrieved from http://psychcentral.com/news/2008/03/12/stress-affects-learning-and-memory/2031.html

Holland, C. (2012). Cultural/Community Mentoring with Maori and Pacific Electrical ApprenticesLiteracy. In *Numeracy Studies* Vol *20*(2). Retrieved from http://epress.lib.uts.edu.au/journals/index.php/lnj/article/view/3084/3273

Krathwohl, D. R. (2002). A revision of Bloom's taxonomy: An overview. *Theory into Practice, 41*(4), 212-218.

University of Cambridge. (2014). Millennium Mathematics Project. Retrieved from http://mmp.maths.org/

Ministry of Education. (2007) *Tertiary Education strategy 2007-12 Incorporating Statement of Educational priorities, 2008-10.* Wellington: Ministry of Education.

Piggott, J. (1997-2012). Bloom's Taxonomy: Stage: 1, 2, 3 and 4. Retrieved from http://nrich.maths.org/5826

Shorser, L. (n.d.). Bloom's Taxonomy Interpreted for Mathematics. Retrieved from http://www.math.toronto.edu/writing/BloomsTaxonomy.pdf

Tennant, V. (2005). The Powerful Impact of Stress. Retrieved from http://education.jhu.edu/PD/newhorizons/strategies/topics/Keeping%20Fit%20for%20Learning/stress.html

Tertiary Education Commission. (2008). Retrieved from http://www.tec.govt.nz/Documents/Publications/Learning-progressions-numeracy.pdf

The Training Place. (2007-12). The Impact of Stress on Learning. Retrieved from http://www.trainingplace.com/source/stress.html

Thomas, G. (2008). The Adult Numeracy Initiative: Its place and value in foundation learning [Ch 11]. In J. Benseman & A. Sutton (2008). *Facing the Challenge: Foundation learning for adults in Aotearoa New Zealand*. Dunmore Publishing Ltd: Wellington.