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# Nursing Students' Readiness for the Numeracy Needs of Their Program: Students' Perspective

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## Abstract

Numeracy needs of nursing students are often underestimated by students when they enter university. Even when students are aware of the mathematics required, students underestimate or overestimate the skills they

have. Research has highlighted the mathematics and numeracy skills required of nurses and nursing students and numerous studies have tested these skills. Research highlighted in this paper investigates students' perceptions of these skills generally, and students' retrospective reflection after having finished a course. Results indicate both an underestimation and overestimation of students' skills when compared to students' results.

Key words: nursing, skills, numeracy

## Introduction

In nursing, the numeracy skills required are considerable. Research with nurses (Blais and Bath 1992; Hoyles et al. 2001) and nursing students (Hutton 1997; Gillies 2003; Galligan 2011) has highlighted the links between nursing skills, particularly drug calculation skills, and underlying mathematics skills. These skills include: number; ratio and proportion; scale; decimals and fractions; rates; measurement; algebra; graphing; and problem-solving. Many researchers have highlighted the proportion of nursing students who have poor skills in these areas (Hoyles et al. 2001). Others have highlighted university students' difficulties with reading graphs (Kemp and Kissane 2010); understanding algebra (Pierce and Stacey 2001) or reading skills, particularly with word problems (Newman 1983). These conceptual barriers are exacerbated at some universities where there is a high proportion of mature-aged students who have been away from formal study for a number of years. While there has been studies investigating nursing students' confidence in mathematics (e.g. Glaister 2007), to date we have not found any research that has investigated students' opinions of their skills after their study.

A four year project, based at a regional university in Australia, aimed to investigate students' perceptions of their mathematical readiness. At this university, the percentage of mature aged students is considerably higher than the sector (58% to 24%) and the percentage of those aged 30 and over is about 45% compared to the sector at about 15%. The number of students identified as low Socio-Economic Status (SES) is 34%, double that of the sector at 17%. The project investigated students' perceptions of their readiness for the quantitative skills needed in their courses after having completed the course. It also correlated this with a mathematics assessment of student readiness, completed within one course. In our preliminary results (Abdulla et al. 2013), we found up to 30% of students in business, education and nursing felt poorly prepared for some of the quantitative components in their courses. However, this was a small preliminary study and did not look at individual courses within a program. Our subsequent surveys in 2014 and 2015 revisited most of the questions asked in 2012. This paper outlines student readiness from the perspective of nursing students and draws on survey data of 160 students in 2015.

## Method

For this paper we draw on data from nursing students enrolled in Semesters 1 and 2 in 2015. Three types of data were used: student surveys on perceptions of their readiness; student results from quizzes in a course; and the student comments at the beginning of semester on their level of skills in selected questions.

Ethics clearance was obtained to survey and communicate with students and staff.

The survey was trialled in 2012 and 2014. Students were encouraged to participate by offering them the chance of winning a $100 book voucher. The survey link was emailed to the students after the semester results had been released and about half of the students also agreed to be interviewed. The average response rate in 2015 was about 10%, noting that we also invited students who dropped the course (see Table 1).

Table 1
*Details on the 2015 cohort*

| Semester (completed final quiz) | No. responses | No. invited | No. cohort dropped |
|---|---|---|---|
| Semester 1 (402) | 48 | 647 | 154 |
| Semester 2 (203) | 29 | 386 | 87 |

The questions that the students were asked included basic demographics. Perceptions of their preparation in various topics were sought using a Likert scale. The topics included: calculator use; decimals; percentages; ratio; algebra; statistics; and problem solving. Students were also asked if their overall mathematical preparation was adequate for the course in question. There were a number of open-ended questions to further explore what factors students understood contributed to their success or failure. While most students answered at least one question on the survey, the response rate for most of the open-ended questions was lower.

Qualitative data from the relevant questions were downloaded into Word and then transferred to NVivo where it was analysed using constant/comparative method (Wellington 2015). Some attempt was made to capture the conceptual as well as the thematic regularities in the data but most of the answers were too terse to be really useful in this regard.

## Key Findings

### Survey

Over 60% of respondents were over 25 years old. While 35% of respondents had studied some mathematics in the last two years (see Figure 1a), a substantial percentage (over 30%) of students who responded to the survey had been away from study for more than 10 years, with many only having completed mathematics to year 9 or 10 (see Figure 1b).

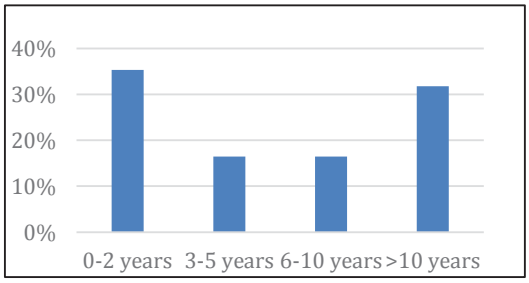


*Figure 1a.* Years between pre-university mathematics and starting Nursing degree ($n$ = 85).

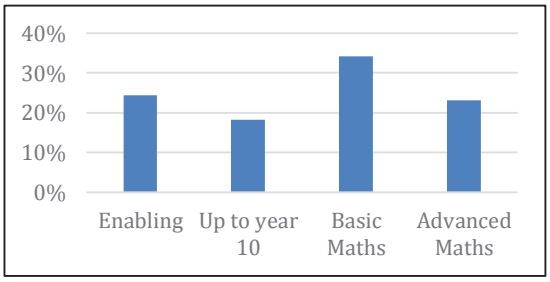


*Figure 1b.* Proportion of students' pre-university mathematics preparation ($n$ = 84).

"Enabling" mathematics is pre-university studies at a college of the university, designed so that students can meet the entry requirements of university degrees. "Basic" and "Advanced" Maths refer to levels of senior high school mathematics; "Advanced Maths" contains calculus.

Figure 2 shows how adequately students felt their pre-university mathematics had prepared them for mathematical concepts encountered in their university studies. Students felt most prepared for using calculators and graphs and least prepared for ratios, fractions and algebra. While students

said they felt less prepared for statistics, there was little statistics in the course (but there was some statistics in other nursing courses).

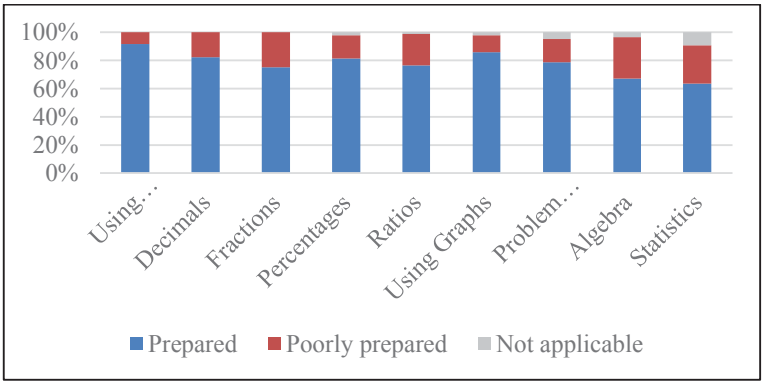


*Figure 2.* Nursing students' perception of preparedness in specific topics.

## Comparison of perceptions with results

The following section compares students' perceptions with results on four quizzes they completed during the semester and a final quiz. All the quiz questions posed had also been discussed in class (or via online lectures) or were in the study materials. Students were asked to do the online quiz within a time limit, and some of the questions were tested multiple times. Previously, Galligan (2011) had found that, in similar quizzes, up to 1/3 of errors could be due to misreading the question. This was also found in many of the questions asked. For example a question:

> Example 1: Write the following in numerals: Eighty Thousand Two Hundred and Six. For example, twenty one = 21. (Note: please do not include spaces or commas in your answer)

In Example 1,70% of the 77 students surveyed were correct in the final quiz. The most common incorrect answer was 8206 and one person each had 800206; 82006; 80,206; 80260 or similar.

### Decimals

Approximately 80% of students surveyed felt prepared for decimals (Figure 3). In the final quiz, when specifically asked questions about: converting from a fraction to a decimal (91% correct); to round to so many decimal places (92%), students were generally competent. However, when asked to read a syringe with gradations, as in Example 2a, only 77% of students were correct by the end of semester.

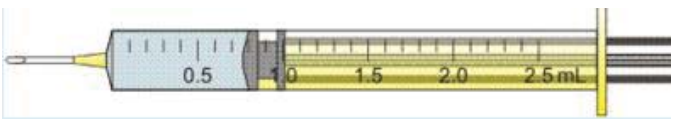


*Figure 3.* Example 2a

On a similar question in three earlier quizzes, 32%; 42%; and 37% of students were incorrect. Of those who were incorrect, at least half was due to reading the gradation incorrectly (i.e. reading the above as 8), as opposed to reading it at the incorrect point (i.e. saying 0.75 or 0.85 instead of 0.8). Similarly, students were asked to read various graphs in a health context. For example when asked to read a temperature (as seen in Example 2b) that needed decimal interpretation, 6% of students were incorrect by the end of semester with many of these students answering 37 or 37.5 instead of an answer above 36.5 and below 37.

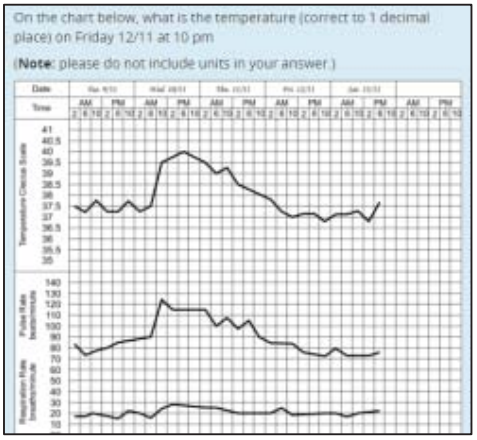


*Figure 4.* Example 2b: Decimals

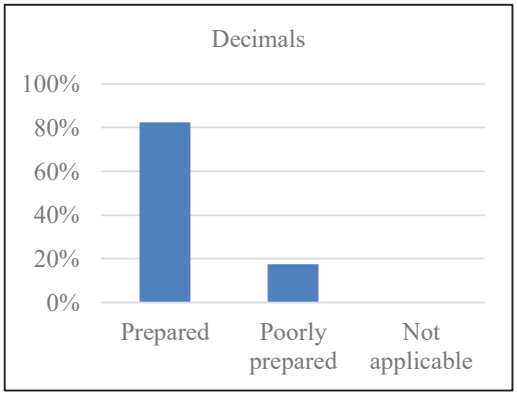


*Figure 5.* Students' perception of preparedness for decimals.

**Fractions**

Figure 4 shows 75% of students felt prepared for fractions. Most students (84%) could convert a fraction into a decimal form (where the fraction was $\frac{1}{a}$ with a $< 10$, Example 3a), and 89% were able to simplify $\frac{20}{120}$ to $\frac{1}{6}$ (Example 3b), but when asked to find a fraction of a number, as in Example 3c, the proportion dropped to 52%.

| Questions involving fractions | % correct |
|---|---|
| a. What is $\frac{1}{7}$ as a decimal? (Quiz 2) | 84 |
| b. Express $\frac{20}{120}$ as a fraction in its simplest form (Final Quiz) | 89 |
| c. Find $\frac{a}{b}$ of 4 mL, if $a$ is 85 mg and $b$ is 190 mg. Answer to the nearest one decimal place. (Quiz 3) | 52 |

*Figure 6.* Example 3: Fractions

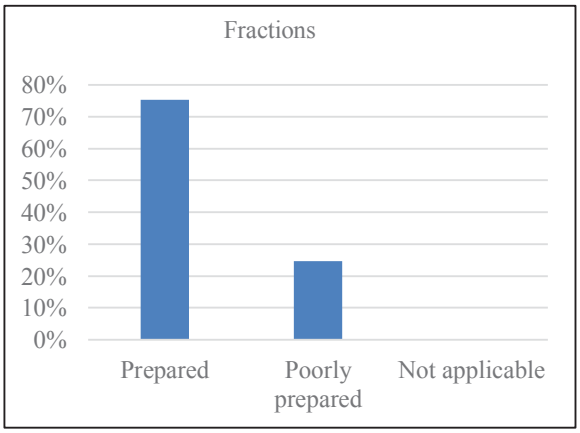


*Figure 7.* Students' perception of preparedness for fractions.

### Percentages

Over 80% of students believed they had adequate skills in percentages (Figure 5), and in the final quiz 90% of students could calculate 30% of 80. However, when tested with contextual problems, the percentage that were seen to be proficient was as low as 46%. For example, in Quiz 3 for a large proportion of students, the mistake was in reading the problem (Example 4). In Example 4a, many of those that did not get the question correct was due to their ignoring the word "remains". In addition, in Examples 4b, c, and d, many students were not rounding correctly. In another question (Quiz 1) asking students to round 23.123 to the nearest tenth, 34% of students were incorrect.

| Quiz 3 questions on percentages | % correct |
|---|---|
| a. A bag of saline solution contains 250 mL. From this bag 139 mL has been drained. What percentage **remains** in the bag? | 46 (increased to 64% in final quiz) |
| b. A person increased weight from 52 to 65. Express this increase in weight as a percentage of the original weight. Answer to the nearest whole number. | 59 |
| c. A person has burns to 9% of her body. If her surface area is about 1.6 square metres, what area of her body has been burnt? Round your answer to **two** decimal places. | 67 |
| d. In a certain country of 25 million people, the number of deaths from heart disease in 2008 was 1809. Express the number of deaths as a rate per 100 000. Answer to the nearest whole number. | 62 |

*Figure 8*. Example 4: Percentages Questions

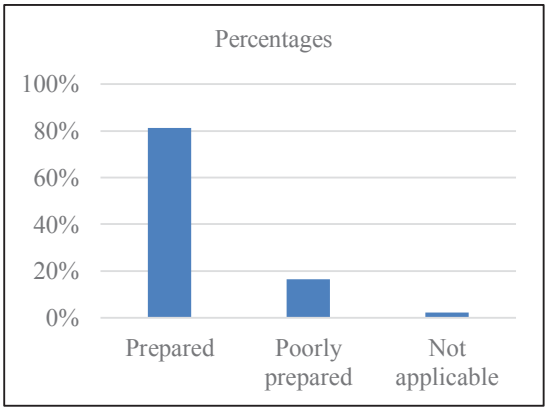


*Figure 9*. Students' perception of preparedness for percentages.

### Ratios

While 75% of students believed they had adequate skills in ratios (Figure 6), when tested the percentage that were seen to be proficient with these particular skills was as low as 54% (Example 5).

| | % correct |
|---|---|
| a. $\frac{2}{5} = \frac{6}{?}$ (end Quiz) | 93 |
| b. $\frac{2}{7} = \frac{?}{5}$ Find ? | 55 (increased to 80% in final quiz) |
| c. If $V = IR$ then $I =$ | 57 |
| d. If $r = \frac{v}{t}$, find $t$ (multiple choice) | 54 |

*Figure 10*. Example 5: Ratios Questions in Quiz 3

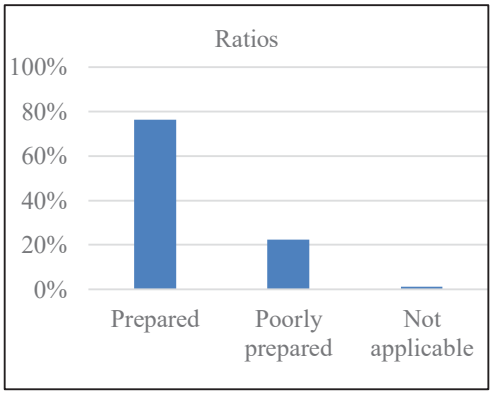


*Figure 11*. Students' perception of preparedness for ratios.

### Graphing

While 86% of students believed they had adequate skills in graphing (Figure 7), when tested the percentage that were seen to be proficient with these particular skills was as low as 57% (Example 6).

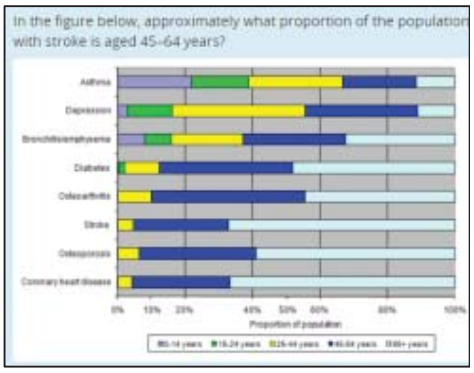


*Figure 12*. Example 6:

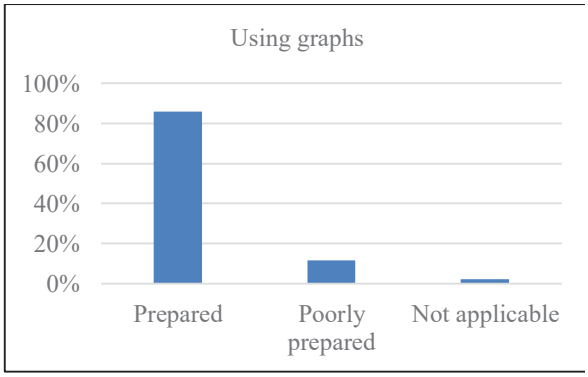


Figure 13. Students' perception of preparedness for graphing.

In Example 6, 43% of students were incorrect with most students answering 33%. This was due to not taking into account those aged 25–44, i.e. not subtracting the 5%.

### Problem solving

While 79% of students believe they had adequate skills in problem solving (Figure 8), when tested the percentage that were seen to be proficient with these particular skills was as low as 34% (Example 7).


*Figure 14.* Example 7: Problem solving

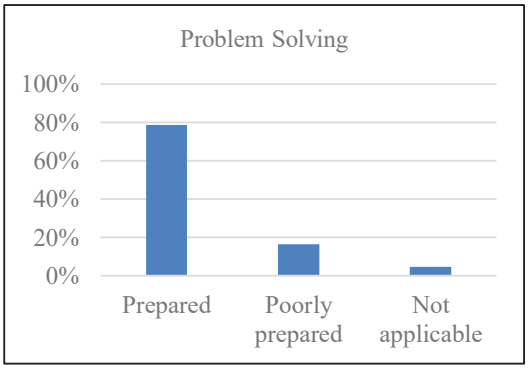


*Figure 15*. Students' perception of preparedness for problem solving.

In Example 7, students were given the label and asked to identify the "amount in each unit" and the "volume" as would be needed in the standard formula. In the quiz 56% and 34% of students were correct respectively.

### Algebra

A greater proportion of Students tended to be under-confident with Algebra, with only 67% stating they were prepared (Figure 9).

| Quiz questions | % correct |
|---|---|
| a. To calculate the volume of an injection a formula is $\frac{SR}{SS} \times V$. Find the volume if $SR = 322; SS = 30; V = 4$ | 96 |
| b. If $B = \frac{w}{h^2}$, what is B if $w = 116$ and $h = 2$ (Round your answer to 1 decimal place) | 91 |
| c. If $V = IR$ then $I = ?$ | 57 |

*Figure 16.* Example 8: Algebra

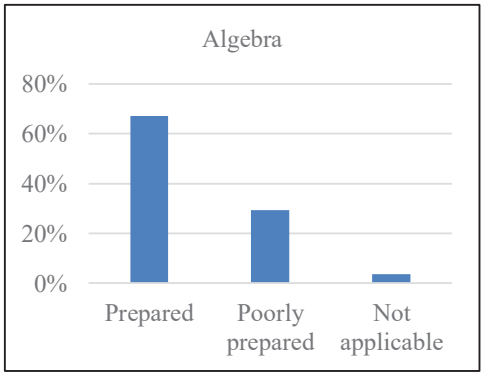


*Figure 17*. Students' perception of preparedness for algebra.

In Example 8, while 96% and 91% of students were correct for Example 8a and b, this dropped to 57% correct for Example 8c.

### Overall

Figure 10 compares students overall mark on a final quiz, which incorporated a variation of all the questions above, and their perception of preparation. In the nursing context, we consider a mark of 85% as well prepared. If students' marks were over 85% then they should perceive themselves more prepared than if they received less than 85%. Note there are 11 (about 20% of the students with over 85%) students who are under-confident, i.e. with relatively good marks but with a perception that they may have not been prepared enough. There are also 15 students (65% of the students with less than 85% correct) who are over-confident, i.e. with relatively poor marks (in the context of nursing numeracy) but with a perception that they were prepared enough.

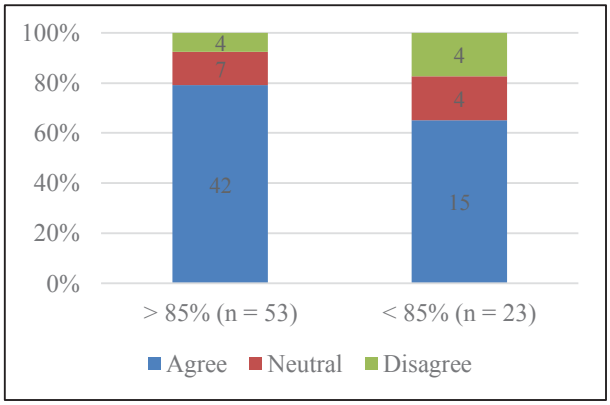


*Figure 18.* Overall mark on final quiz and perception of preparation.

## Discussion

When answering the question "Was your overall mathematical preparation adequate for the course [ABC]" we realise students may take different perspectives. Some students may think that even if they were incorrect in some questions, their mathematics preparation was adequate since they passed the course. Others may think that even if they were correct in most of the questions, and received over 85% in the course, there were feelings of uncertainty around some concepts. We wanted to explore this a bit further. Figure 11 summarizes the comparison between students' perception of their readiness and the results of one question in each of the topics (examples 2a; 3b; 4a; 5b; 6; 7; and 8b). The choice of the question was subjective, but we felt if we averaged the results, we would lose the essence of the concepts. For some of the topics there was overlapping concepts, so the problem with a question such as rearranging a formula V = IR could be related to algebra or ratio and the fact it may be related to both, could compound the problem and cause an increase in error rate. Another issue is students' careless reading of many tasks and their misunderstanding of "rounding", so at times the error rate reflects both difficulties in a concept, as well as other factors. Of the seven topics, two of them show some mismatch – graphing and algebra. It appears that students are over-confident in graphing and under-confident in algebra.

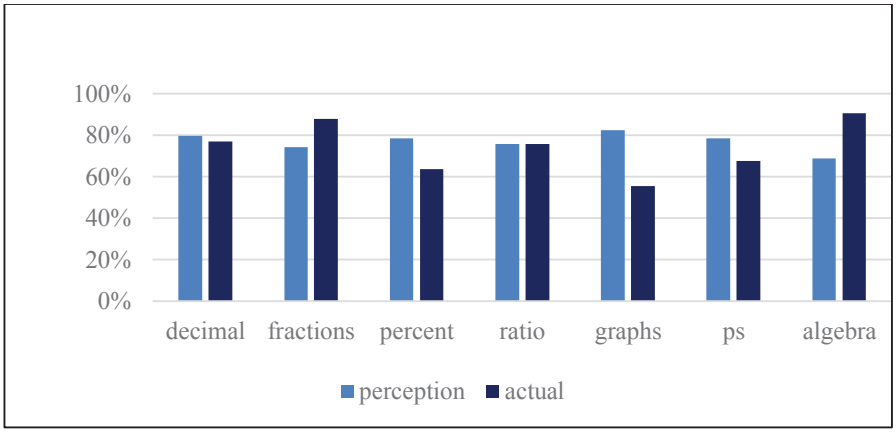


*Figure 19.* Summary of the difference between students' perceptions and their results in one question in their quiz.

Table 2 highlights these differences (shaded area) with 38% of students saying they were prepared but were incorrect in the graphing question (Example 6) and 30% of students saying they were not prepared but were correct in the algebra question (Example 8b).

Table 2
*Two-way table of students' perceptions and their results in selected questions in graphing and algebra*

| Graphing | Prepared | not prepared | Total |
|---|---|---|---|
| Correct | 33 (45%) | 8 (11%) | 41 (55%) |
| Incorrect | 28 (38%) | 5 (7%) | 33 (45%) |
| Total | 61 (82%) | 13 (18%) | 74 |
| **Algebra** | **Prepared** | **not prepared** | **Total** |
| Correct | 45 (61%) | 22 (30%) | 67 (91%) |
| Incorrect | 6 (8%) | 1 (1%) | 7 (9%) |
| Total | 51 (69%) | 23 (31%) | 74 |

## Conclusion

This paper is part of a larger study on university students' perception of their readiness for the quantitative skills of courses they have completed (Abdulla et al 2013) and is a follow up study to previous research on lecturers' perceptions of their students' readiness (Galligan et al. 2013). In this current section of the study, we investigated first year nursing students' perception of their readiness for one course in nursing numeracy and compared this perception to student results.

We found up to 35% of students surveyed felt less than prepared for some elements of their course. When comparing surveyed students' perceptions with final quiz results, up to 65% of students were overconfident on their level of preparedness. While students appeared competent in many of the basic areas of mathematics, when questions became more complex, the competence level

decreased. In the context of teaching nursing students numeracy, it is important to highlight to students the complexity of many of the basic numeracy skills encountered in their nursing degree and careers. In particular, students appear to be overconfident in their interpretation of graphs, and are unaware of other numeracy skills required to correctly interpret graphs (Kemp and Kissane 2010). On the other hand, students often find algebra a sticking point in their mathematics learning and are often unaware of the skills they already possess. Students may not be able to perform many of the tasks set by them in high school (such as rearranging equations or factorising expressions) but they are able to understand and use formulas in the context of nursing.

As the survey response rate was relatively low, care needs to be taken with generalisation of any results. However, the under and over-confidence rates do generally match previous results in similar research (Galligan 2011). While this study is in one university in Australia, the issue of student perception of preparedness is applicable in any higher education context where quantitative skills are assumed. In particular, it is relevant to such institutions where there is a high proportion of mature aged students and students who are unfamiliar with the expectations of university. There is a need to provide students with clear guidelines as to the standard of mathematics expected of them at the onset of their study. Good support and enabling programs also need to be in place to assist underprepared students to realise these expectations, so they can be retained as successful students and progress to become quantitatively competent and confident in their career.

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