CASE STUDY

Supporting nursing students' mathematical understanding

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Abstract

A key component of any nursing course is the ability to confidently, and competently, use basic mathematical skills. Indeed, without such skills they would be unable to work safely and successfully in the profession (McMullan, Jones, and Lea, 2012; Choudhary and Malthus, 2017). Furthermore, many nursing students come on to their courses having not studied any form of formal mathematics for years and are very likely to have some form of maths anxiety (McMullan, Jones, and Lea, 2012). **sigma** Maths Support at Coventry University have developed a programme, in partnership with the Faculty of Health and Life Sciences (HLS), to support these students with their mathematical skills using a variety of small interventions. The interventions require little time and effort to prepare and have proven to be very successful. This article will discuss the methods used, including diagnostic testing, the use of 'Numbas', and self-explanation training (as described in Hodds, 2017), alongside the outcomes of the programme.

Keywords: Mathematics support, Nursing, Self-explanation, Numbas, Coventry University.

1. Introduction

When students make their decision to study for a degree that is traditionally considered non-mathematical, they often do not consider that there may indeed still be mathematics contained within it. Moreover, if a student has a fear of mathematics then that will influence their choice of degree once they leave school (Dowker, Sarkar, and Looi, 2016), particularly since studies have shown that attitudes towards maths deteriorates as students reach adolescence (e.g. Wigfield and Meece, 1988, Ma and Kisnor, 1997). To try to help these students, many universities in the UK now have a form of mathematics support provision. Initially, these provisions were set up to help improve the declining mathematical skills of undergraduate students on courses with high mathematical content, such as engineering (Lawson, Croft, and Halpin, 2003), but more recently these provisions have expanded to offer more support to non-mathematicians (Grove, Croft, and Lawson, 2019). Non-mathematicians are more susceptible to maths anxiety however and, therefore, just seeking out the support and stepping through the door can be a daunting task.

One such group of students are nurses. These students have very basic mathematical content on their course, such as percentages, fractions, simple addition and subtraction, and using formulas. It is important that these students have good mathematical abilities in order to have a successful career and practice safely (Choudhary and Malthus, 2017); a lower mathematical ability has also been shown to be the main factor in predicting drug calculation ability (McMullan, Jones, and Lea, 2012). Of course, safe drug calculation is important for nurses as without those skills they pose a risk to patient safety (Renmarker and Carlson, 2019). However, nursing courses also often require their students to achieve 100% in any final year mathematics exam putting more stress on students who are already usually anxious about mathematics.

The demographics of nursing students may also prove to be a hindrance to their mathematical understanding. Nursing students are often older than typical undergraduate students are and therefore may not have had formal mathematics training for many years. As stated previously, it has been shown that as students get older their attitude towards mathematics deteriorates (e.g. Wigfield and Meece, 1988, Ma and Kisnor, 1997) so, for these students in particular, this can be a serious

problem. Furthermore, Zakaria and Nordin (2008) showed that there can be a negative correlation between maths anxiety and motivation to study mathematics. Therefore, the combination of not studying any form of mathematics for many years and generally being older students, leads to low motivation to study mathematics and high anxiety towards it.

To help students on all courses at Coventry University, the **sigma** Mathematics Support Centre offers support to students through drop in sessions for over 50 hours a week in term time, alongside many other forms of support. Data on student entry to the support centre is collected via a card reader which students tap their ID card on to when they first arrive. Figure 1 below shows the data for student entries by faculty for the academic years from 2015 to 2018.

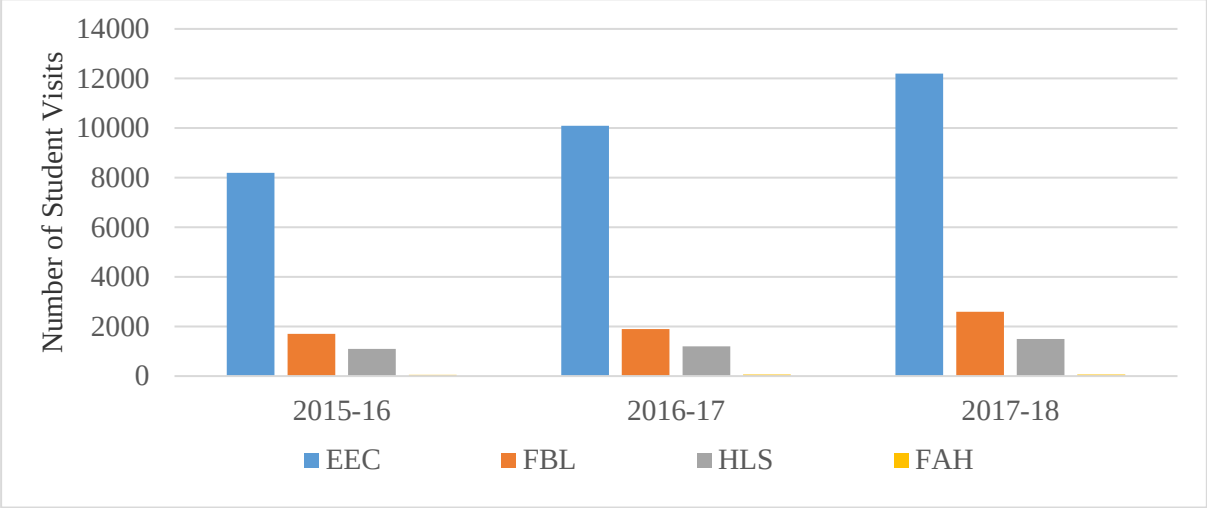

Figure 1: Visits to Coventry University Mathematics Support Centre by Faculty and Academic Year

The data shows that the majority of student visits come from the Faculty of Engineering, Environment and Computing (EEC), which has engineering, computing and mathematics courses. These courses have high mathematical content whereas the other faculties (Faculty of Business and Law, FBL; Health and Life Sciences, HLS; Faculty of the Arts and Humanities, FAH) have less mathematical content in their courses. Nursing is based in HLS where numbers year on year had increased for visits from students in that faculty. However, for 2017-18 visits from nursing students had declined significantly. Furthermore, students who were visiting the centre were mainly visiting in the week of, or the week before, their final exams. Obviously, this was not enough time to get the support they needed and pass rates for their final numeracy exams were only at 75%.

Data from a survey given to first year students revealed some of the reasons why non-mathematics students in general were not coming to seek the support they needed. Comments included *"I should be able to do this – it's not even GCSE level maths"*, *"I'm worried my lecturer will find out that I am struggling"*, and *"I hate maths, I'm not very good at it."* For those who work within mathematics support, this is probably unsurprising but there is a clear trend in these comments that link back to maths anxiety and motivation discussed previously. However, a further comment suggested that when they do come for support, they gain confidence: *"I have just had a… session with a tutor and honestly it was amazing. She was so kind and patient with me. I feel confident now to continue on the biomedical science course knowing that I can come here as often as I like for maths support… I was thinking I would fail just because of the maths side of the course. I am not even that bad at maths, I just need a little extra help to understand what I am doing. Thank you so much and please continue the… support sessions."* It is clear that if students access the support on offer it can be beneficial to them. It therefore seemed reasonable to improve nursing student awareness of the support on offer and increase the support offered to them. Hence this provided the motivation for

producing some interventions for student nurses at Coventry University to see if their mathematical understanding could be improved.

2. Interventions provided to improve understanding

In the 2017-18 academic year there were only three main methods of maths support available to nursing students. These were formal teaching and office hours from nursing lecturers within the faculty, an intervention session on the basics of nursing mathematics from a member of **sigma** staff, and general maths support within the **sigma** Mathematics Support Centre. Not all nursing courses received the intervention session due to time available from **sigma** staff, so some nursing courses only had two methods of maths support available. For 2018-19, four further methods of support were made available.

The first method of support was a bespoke diagnostic test designed specifically for nursing students. The test contains questions on order of operations, percentages, basic calculations, fractions, conversions of units and simple drug calculations using given formulae. The test was given in week one of the course and the results showed students their areas of strength and weakness. For the topic areas that needed improving, the results provided links to worksheets available from the **sigma** support website that students could work through in their own time.

The second intervention was to provide students with a self-explanation training booklet, as described in Hodds (2017). The self-explanation training method has been shown to be effective at supporting the understanding of both mathematics students (e.g. Hodds, Alcock, and Inglis, 2014) and non-specialist mathematics students (Hodds, 2017). The training booklet is designed to help nursing students understand how to deconstruct questions and unpick the mathematics, allowing them to answer the question using the methods taught within lectures. Indeed, one of the reasons why some nursing students fail is not because they cannot do the maths, but instead they cannot understand what maths to use given a particular situation (Hodds, 2017).

The third intervention was to provide students with online interactive questions using the platform ‘Numbas’. These online questions are designed so that students can attempt exam style questions many times but with different numbers and variables for each attempt. Since the questions are online, the students can attempt them anytime, allowing for a continuous method of support. Furthermore, these questions were embedded within the university’s online learning environment (CU Moodle) so the lecturers could see how well students were progressing through each topic. This allowed the lecturers to invite students who were struggling to consider getting further support to improve their understanding.

Finally, to encourage students to visit the **sigma** Support Centre for support, members of the nursing team provided up to 5 hours per week of support time within the centre. Not only does this help students to find the centre, it helps them to realise the centre is a place where they can get support without judgement, breaking down the anxiety barrier. As the member of the nursing team is a familiar face, students are more likely to come and use the centre whilst also seeing that permanent members of the **sigma** team are available for friendly help and support also.

For clarity, the table below compares the previous support available to nursing students in 2017-18 compared to the support available in 2018-19.

Table 1: A comparison of the support available to nursing students in 2017-18 to 2018-19

Support during academic year 2017-18	**Support during academic year 2018-19**
Formal teaching from faculty staff	Formal teaching from faculty staff
Intervention session from **sigma** staff	Intervention session from **sigma** staff
General support in the **sigma** Support Centre	General support in the **sigma** Support Centre
	Bespoke diagnostic test in week one
	Self-explanation training booklet
	Interactive 'Numbas' questions online
	Formal support from Nursing lecturers in **sigma** Support Centre

3. Results

Firstly, the pass rate in the end of year maths exam for three nursing courses (where the full range of support during the academic year was offered) were considered: Non-Medical Prescribing (NMP), a final year masters course, Community Nursing Prescribing (CNP), an undergraduate course, and Adult Nursing first year undergraduates. For NMP, the pass rate was 80.3% and for CNP, the pass rate was 97.3%, both up from 75% in 2017-18. For CNP, only two students failed in the entire cohort of 73 students. For Adult Nursing, the pass rate was 92.6% but there was no comparison as there previously was no exam in the first year. Although direct causation cannot be suggested, it does appear that the interventions had at least some positive effect on understanding as all other factors to do with the courses (such as timetabled sessions, exam timings, types of exam questions, etc.) remained consistent.

Secondly, the diagnostic test scores for the first year Adult Nurses were correlated with their final exam scores to determine whether there was any relationship. Indeed, a Pearson's Correlation revealed that the diagnostic test score was a good predictor of the final exam result, $p < 0.001$, $r = 0.666$, and is shown in the graph below, coloured by how many visits to the **sigma** Maths Support Centre each student made.

The result suggests that the better the student did on the diagnostic test, the better they did on the final exam. However, since it is not a perfect correlation, it shows that students were able to improve if they came to the centre for support. Moreover, the more times they visited for support, the more they generally improved. Indeed, those students who visited the centre more than once had an increase of 23.1% on their score from the diagnostic test to the final exam, compared to those who did not visit or just visited once, who had an increase by 14.5% on average. However, this difference in improvement did not quite reach significance, $t(65) = 1.829$, $p = 0.072$. Nevertheless, the result indicates that the new diagnostic test was a good predictor of exam performance but by visiting the centre, students' understanding would generally improve, resulting in an improved performance in the end of year exam.

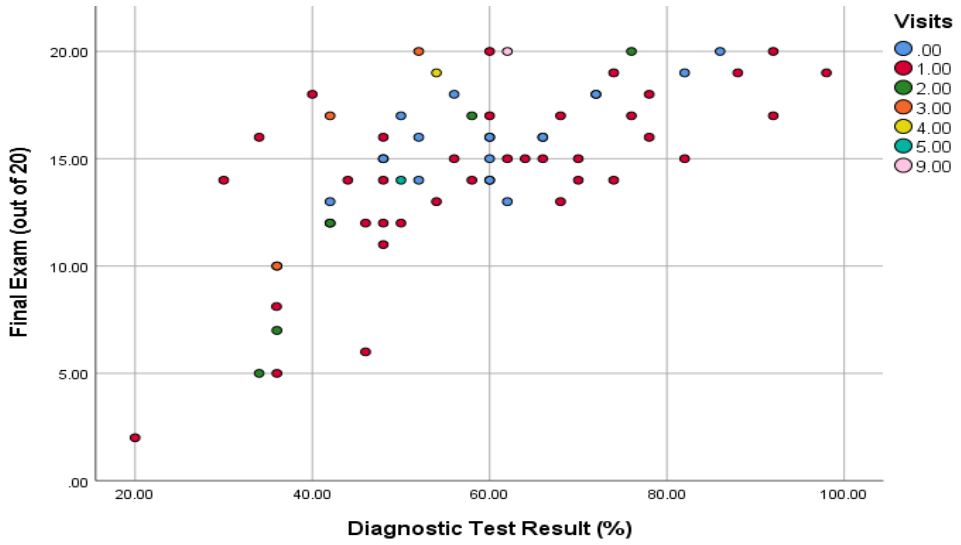

Figure 2: Correlation between diagnostic test score (%) against final exam score (out of 20) for first year Adult Nursing undergraduates by how many visits made to the **sigma** Maths Support Centre

Finally, the number of nursing student visits to the sigma Mathematics Support Centre was considered to see if more nurses were seeking the support they needed. Indeed, the number of visits from nursing students increased significantly from 60 visits in 2017-18 to 340 in 2018-19. Having a member of staff provide support hours in the centre really increased awareness of the service to the students and helped to reduce the worry about crossing the threshold of the centre to obtain support. The graph below shows the change in the number of nursing visits to the sigma Mathematics Support Centre for the academic years from 2012-13 to 2018-19.

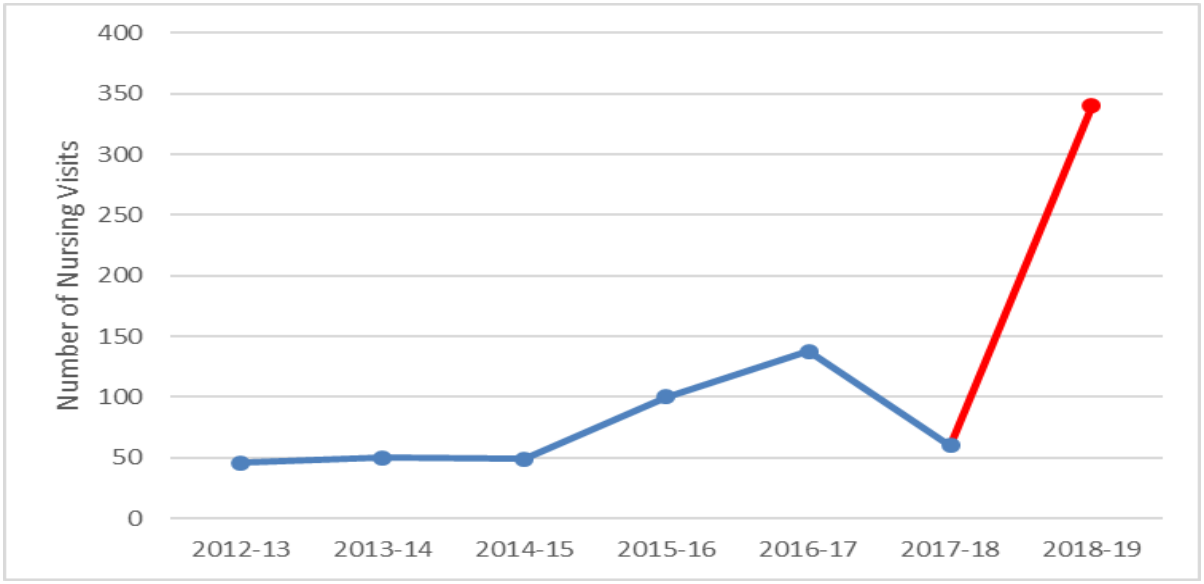

Figure 3: Nursing student visits to the **sigma** Maths Support Centre by academic year

4. Discussion

The interventions described have proven to be successful in improving nursing students' mathematical understanding at Coventry University. These interventions have had at least some influence in helping 289 nursing students pass exams with mathematical content in 2018-19. Clearly,

this is a positive outcome and will therefore have had some positive financial impact on the university, but exactly how much is a difficult question to answer.

One measurement we can consider is how many nursing students from various vulnerable groups we are helping to progress. As part of universities' impact statements to the Office for Students, mathematics support centres and provisions in the UK now have to consider exactly how they are supporting students from several key groups, historically shown to struggle, to pass their degrees. Two of the key areas are students from minority ethnic backgrounds and mature students. The initial work described above is a good case study for the sigma Mathematics Support Centre as 34.2% of the nursing students in 2018-19 were from minority ethnic backgrounds and 53.8% of the nursing students were mature students. More work needs to be done to complete the statistics for this but it will provide a useful evaluation tool going forward.

Work has already begun to increase the support offered to nursing students in 2019-20. For example, the Adult Nursing course will now have online work each week to complete using 'Numbas' in the second year and collaborative workshops with both sigma staff and faculty staff in the final year. Furthermore, in September 2019, the first cohort of nurses at the Scarborough satellite campus completed the diagnostic test as it was made available online for the first time. Offering support to students not based on the main campus in Coventry is a big gap that sigma are looking to fill and online remote support seems to be the way to do this. Indeed, work is currently taking place to train staff to be able to provide one-to-one mathematics support sessions using an online meeting space called 'Big Blue Button' whilst writing on screens using styluses and tablets.

To conclude, this article has shown that it is possible to improve the mathematical understanding of non-mathematicians, and nursing students in particular, by adding a few simple interventions. Each intervention was rarely time consuming and, once completed, can be used over again and improved upon, reducing the time needed to produce support materials in the future. Furthermore, getting faculty staff to offer time and support within your own support provision can really help to break down any barriers or stigmas attached to seeking much needed support. As a maths support practitioner, you may need to approach faculty staff and offer a quid-pro-quo in order to get them to support you but doing so can be extremely effective. Since non-mathematicians are often reluctant to ask for help, as they are either anxious or they see it as a weakness, faculty staff can be a useful link between your provision and a student. Providing a supportive environment with a friendly face students recognise can therefore be the first step on the road to helping these anxious students see maths support as a useful tool in their degree journeys. Indeed, in 2019-20, there have been 390 nursing student visits (up to November 2019) to the sigma Mathematics Support Centre which is already 30 more than the whole of last academic year. Finally, it is important to stop and reflect to ensure what has been implemented is having a positive impact. The work of maths support provisions in the UK is being further scrutinised by universities, so detailed evaluations showing exactly how the provision is increasing student engagement and retention can only help to support the impact the service is making.

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6. References

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