

## **Drug Calculation and the Mathematics required for Nursing**

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Mathematics is a very old discipline and hence the teaching of mathematics has a long tradition, however in today's university the students needing to apply some form of mathematics in their studies is ever increasing, none more so than in nursing. During 1999 the publication of the Government's 'Making a Difference' document [1] set out an agenda for significant change in the way that pre-registration nurses are educated and trained to meet the professional standards, the needs of the NHS and the complex demands of health and social care in the 21<sup>st</sup> century. In response London South Bank University (LSBU) launched a new curriculum for pre-registration Nursing in September 2000. The new programme had been developed with educationalists at LSBU and colleagues in health and hospital trusts. Nursing was previously taught and studied in teaching hospitals and separate from the traditional university system, the modern nursing student is now part of the university system. At LSBU students do their practical work in local hospitals and the majority of their studies at one of LSBU's campuses.

The rapidly increasing number of students undertaking pre-registration nursing, at the time of writing the number of students is in the order of 2000 at LSBU, looks set to continue to rise. A new structured programme that combines more practical experience with a greater focus on the students chosen specialist areas was to be implemented. The programme sought to attract students with a wide range of practical and educational experience. The Nursing courses are designed around an outcomes-based competency approach to education in order to ensure that nursing practice is examined from many perspectives. This approach is sought to encourage the development of knowledge, understanding, practical and technical skills, attitudes and values. The integration of theory and practice were to go hand in hand from the very beginning of their studies. From a mathematical perspective we at LSBU have found that there is an essential requirement for remedial and catching up classes in mathematics to aid students who have difficulty in this area of their studies. Since these types of classes were comparatively new phenomena, with no established tradition, there was a need for new innovative methods and modes of delivery to help these students.

A number of factors needed to be taken into account when designing the structure and for well qualified and experienced staff to be available. At LSBU we tend to use a range of staff that have expertise in helping students at the FE/HE transition level. For example staff who have taught Access or Foundation courses in FE colleges and those who have a medical or nursing background have seemed to be the most appropriate teaching staff. This is rather difficult to resource as not many tutors have a nursing and mathematical background. At LSBU we are very fortunate in having found two part time members of staff who have a teaching qualification in mathematics and a nursing background. A considerable number of nursing students who come to use the service are in the first year of their study at university. Hence the need for experienced tutors is essential at this level. In previous years, when

students entered HE with a sufficient grasp of the mathematics required, these type of staff would not have been required and the ordinary HE lecturers would have been sufficient.

There is a lot of work initially in setting up appropriate teaching and support mechanisms for nursing students for example:

- Diagnostic tests to identify student's strengths and weaknesses
- Extra classes to cover the weaker areas
- Relevant discipline specific teaching materials
- Evaluation feed back mechanisms to be implemented
- On-going support
- What to do with fully trained nurses who need help.

All trainee nursing students follow a drug calculation unit at some stage during their training. Correct measurement of drug dosages are important. There is an imbedded assumption and essential entry requirement that students have a GCSE or equivalent mathematics qualification. Hence the tutor should be able to assume that the students have pre-requisite knowledge and experience in fractions, decimals, percentages, ratio and proportion and unit conversions. This assumption cannot be assumed since many of the students have forgotten the mathematics they did previously and hence this vital area of mathematics for drug calculations must be covered. Another factor is that students have developed their own attitudes to mathematics and often see mathematics to be difficult and the prerogative of 'clever' people.

The first stage was to develop a diagnostic test to identify the student's strengths and weaknesses. The Learning and Development Centre at LSBU designed the test with input by the academic staff from our Health and Social Care faculty. The test contained questions on mathematics, English and biology so a complete profile of the students could be obtained. This test was then used on all new pre-registration nursing students at LSBU. The test mathematics questions were on basic number skills and manipulation, fractions, decimals, percentages and powers. Example questions were:

### Decimals

Round off the following to two decimal places:

$$3.5741 = \underline{\hspace{2cm}} \quad 10.11111 = \underline{\hspace{2cm}} \quad 91.0054 = \underline{\hspace{2cm}}$$

$$9.0009 = \underline{\hspace{2cm}} \quad 0.9182 = \underline{\hspace{2cm}}$$

### Complete the Calculation

Use the numbers below to complete the calculations:

15	5	$\frac{43}{5}$	10	20	36	20	-36	$\frac{21}{5}$	3
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$$4(3 + 2) = \underline{\hspace{2cm}}$$

$$3+2 \times \frac{4}{5} = \underline{\hspace{2cm}}$$

$$12 \times (5 - (6 + 2)) = \underline{\hspace{2cm}}$$

20% of 100 = \_\_\_\_\_      10% of 50 = \_\_\_\_\_      5% of 60 = \_\_\_\_\_

We ran the test on-line and questions were electronically marked and the students profile obtained as a hard copy. A paper copy of the test was also available should their be problems with the computers and was to be used at some of our smaller campuses at LSBU for example at Harold Wood hospital. Students who obtained scores of less than 40% were scheduled to attend the extra classes, those who obtained 40-49% were recommended to attend and those above 50% could attend if they wished. Only ten percent of the class obtained full marks for the mathematics test.

<b>Percentage of students in each category</b>	
Extra Classes scheduled	22%
Recommended to attend	10%
Option to attend	68%

We found that many of the students who were recommended to attend or had the option to attend did so and the comments were that they wanted to brush up on their skills. We ran 10 hours of extra maths classes.

The classes covered the following topics i.e. fractions, decimals, percentages, ratio and proportion, use of formulas and conversions. These classes were taught by one of the two mathematics teachers who had the nursing background. The material used could have come from the standard GCSE type such as Greer [2], however, we at LSBU felt that discipline specific material would be more appropriate to the students. All the topics were set in a nursing context.

**Examples of specimen questions from our material would be:**

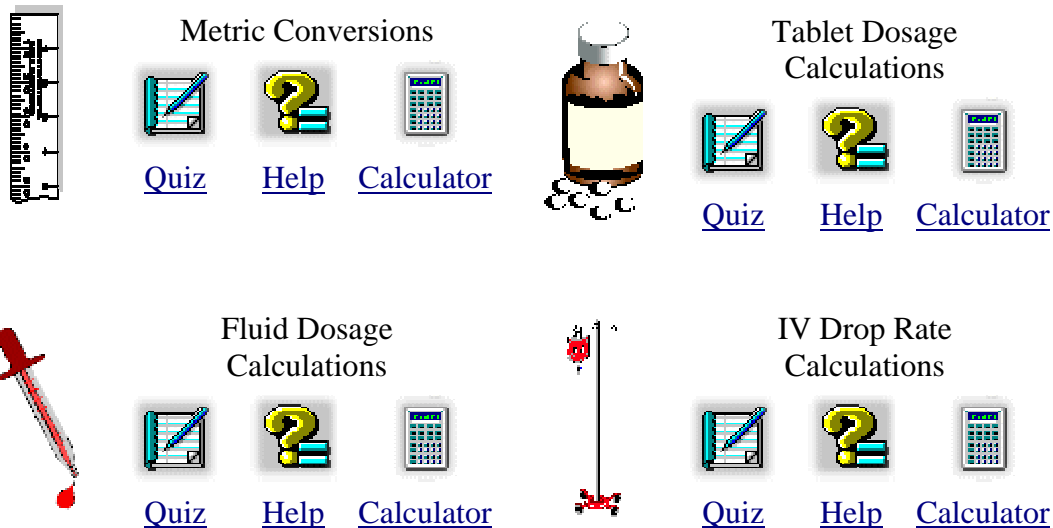
1. Mr Krause requires analgesia. He can have Paracetamol Elixir 500mg 6 hourly. The elixir contains 250mg in 10ml. How much should you pour out? His first dose is to be given at 12 noon. List the times for the next 24 hours of his doses.
2. A child weighs 7.2 kg has been prescribed frusemide (one mg per kg). How much would you administer in volume if the drug came prepared as 10 mg in one ml?

We also used on-line resources such as Nursing Standard Quick Reference Guide – Numeracy Skills [3] and Drug Calculations [4] their websites are:

<http://www.nursing-standard.co.uk/archives/residentpdfs/quickrefPDFfiles/Quickref1.pdf>  
<http://www.nursing-standard.co.uk/archives/residentpdfs/quickrefPDFfiles/Quickref2.pdf>

Students particularly liked the following website

<http://www.geocities.com/HotSprings/8517/Quiz/quiz.htm> since they could work through at their own pace. Below is how the website presents itself.



These four tests have been created by the software program [Drug Calculations for Nurses](#). They consist of twenty questions complete with help, answers and solutions to the problems.

You can download Drug Calculations for Nurses and practice

**Two specimen example questions, from the website [5] are as follows:**

There are many occasions when nurses need to convert a number from one metric unit to another e.g. You are required to give 1 g of a drug and you have 500mg tablets available. The nurse needs to know that there are 1000 milligrams in 1 gram and s/he will therefore give two tablets. There will be times when the conversion is considerably more complex than this and the nurse will need to have a good grasp of the principles of metric conversions. This test consists of 20 questions, which are designed to assist in learning the principles of metric conversions.

**Instructions:**

- Enter your answer in the box provided
- Click [check](#) to see if you have answered correctly
- Click [show me a correct answer](#) to see the correct answer
- Click [show me the solution](#) to see the formula used

**1. Convert 93074 milligrams to grams.**

[Check](#)

Show me the correct answer

Show me the solution

To convert 93074 milligrams to grams the computer used the following formula:

$$93074 \text{ milligrams} \times 0.001 = 93.074 \text{ grams}$$

The decimal place has been moved 3 places to the left.

Using formulas is an essential skill that nurses need to obtain, for example see the question below:

**Example:**

A client is ordered 45 mg of Loxapine by intramuscular injection. 50 mg in 1 ml of liquid for IM Injection is available. How many mls will you administer?

The formula to use is:

$$\frac{\text{Required dose}}{\text{Stock dose}} \times \frac{\text{Stock Volume}}{1} = \text{Volume to be given}$$

The numbers are now placed in the formula:

$$\frac{45 \text{ mg (required dose)}}{50 \text{ (Stock dose)}} \times \frac{1 \text{ ml}}{1} = 0.9 \text{ ml}$$

The only problem with this website is that students can use a calculator to do the questions, whereas at LSBU the students have to be able to do the answers without a calculator. At LSBU we only use the website for practice questions, however, the website also includes the ability to:

- Customise almost all of the testing features in Drug Calculations for Nurses.
- Keep a log file of the results of all users who access Drug Calculations for Nurses.
- Include a shared log file across a network.
- Keep separate records for every user who accesses Drug Calculations for Nurses.
- Request an ID number and / or name of a user when Drug Calculations for Nurses is run.
- Check peoples ID numbers against a list and record only the results of those who are on the list.
- Create test conditions and practice modes.

At LSBU we also provide on going support for the nurses during their training see [www.lsbu.ac.uk/caxton/](http://www.lsbu.ac.uk/caxton/) for the latest timetable of our support classes. We have not really addressed the problems that fully trained nurses have who need help.

Technically they are not LSBU students but the moral issue is here do we turn these nurses away in their hour of need?

After the 10 hours of mathematics classes the students were then re-tested with discipline specific questions as opposed to the diagnostic test, which was of the standard type of mathematics questions. Student's scores rose by at least 25 percent in all cases. It was considered that these extra classes were worthwhile and propose to adopt this procedure in future. We have all seen in the papers stories of where drug calculations have been incorrect. A recent BBC article 'Dangers of drug errors exposed' reported that

"Thousands of drug injections errors are probably made every day in NHS hospitals, say researchers. When nurses give drugs intravenously, they are making mistakes in almost half of the injections because they are poorly trained, the study says. Some of these are putting patients at risk. At least one patient every day in every major NHS hospital may experience a potentially serious error." [6]

The report recommends that nurses be given better training and technology to help them give intravenous (IV) drugs properly. The team observed the preparation and administration by nurses of IV drugs, which are injected into the vein, over six to 10 consecutive days on 10 wards in the hospitals. According to Professor Nick Barber of the University of London "Errors which might not matter with other patients could be very serious cases." [6] Just over 100 patients were given 430 doses of IV drugs during the period and errors were seen in 212 doses. A third of these were potentially harmful and in three the error was potentially severe where long term hospital care or even death could occur. So there is an obvious need to make sure that our nurses are properly trained in the mathematical calculations required for their profession.

An article by the American College of Physicians (ACP) [7] states that statistics show that nearly half of all drug errors are the result of problems in the prescribing process. The ACP recommends seven simple steps to prevent outpatient drug errors. Step number 6 states that those prescribing drugs should:

**Avoid decimals.** Use 500 mg instead of 0.5 g, for example, and 125 mcg (micrograms) rather than 0.125 mg. You should also avoid using the terminal 0 (as in 1.0 mg). The decimal point might not show up clearly if the paper is lined or the prescription is faxed. [7]

This is probably the most useful from a mathematical perspective to help avoid errors. I would like to add that handwriting is also difficult to follow at times and hence nurses could make an error, not due to the mathematics they use but due to reading the handwriting incorrectly. We at LSBU can teach the mathematics but reading handwriting is another issue. We always tell the students if in any doubt refer back to the person who prescribed the drugs.

Student evaluation results, from the classes, has been favourable. Comments from the students were as follows:

"useful for gaining a basic understanding before the drug unit starts"

“more time would have been nice, but I did find it helpful”  
“the tutor understands the maths and the nursing bits!”  
“well done for finding an excellent tutor”

It is clear from these comments that the students value the classes and in particular contact with a member of staff with the required mathematical and nursing expertise. We at LSBU plan to continue to offer this service . Should you need any further information regarding the service we provide for nurses at LSBU then please feel free to contact me by email at the above address.

## References

[1] Department of Health, Making a Difference: Strengthening the nursing, midwifery and health visiting contribution to health, Department of Health, 1999  
[www.doh.gov.uk/nurstrat.htm](http://www.doh.gov.uk/nurstrat.htm)

[2] A Greer, A complete GCSE Mathematics higher course 3rs Ed., Stanley Thornes, 1992

[3] Nursing Standard Quick Reference Guide – Numeracy Skills,  
<http://www.Nursing-standard.co.uk>

[4] Nursing Standard Quick Reference Guide – Drug Calculations  
<http://www.Nursing-standard.co.uk>

[5] Drug Calculation Quiz Page  
<http://www.geocities.com/HotSprings/8517/Quiz/quiz.htm>

[6] BBC Report, Dangers of drugs exposed, 28 March 2003  
<http://news.bbc.co.uk/1/hi/health/2891327.stm>

[7] Seven simple steps to prevent outpatient drug errors, American College of Physicians, Bonnie Davies, 2003  
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