Enhancing student nurses’ maths confidence and ability via numeracy drop-in sessions

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**Abstract**

**Background:** The aim of the study was to explore how maths confidence and anxiety affect the ability to learn maths and to investigate if numeracy drop-in sessions support maths learning and improve confidence.

**Methods:** A mixed methodology was used, utilising both quantitative and qualitative data collection tools. Registered nurses on a nurse prescribing course participated in the study; data collection was done via a pre and post intervention maths tests, questionnaires and interviews. The data analysis produced three themes, Personal Maths Experience, Effect of Drop-in Sessions and Experience of Sessions.

**Findings & Results:** For the pre and post intervention maths tests results were compared using a paired two sample t-test the t-stat was greater than the critical t-value showing that maths ability had improved. From the questionnaires and interviews the participants indicated that both their confidence and ability had improved.

**Conclusions:** All participants found the numeracy drop-in sessions beneficial in improving both maths confidence and ability, findings indicated that post-test scores had improved in comparison to pre-test scores.

**Introduction**

Drug errors are the cause of 25% of all legal proceedings in the NHS (Wright, 2005). According to the NPSA, (2007) calculation errors that result in medication errors cost the NHS more than £750 million pounds per year. Patient safety is paramount, but the NHS cannot ignore the rising costs related to these errors particularly in the current financial climate, where cuts are being made in the NHS to reduce spending (Hunter, 2010). Tang et al. (2007) specified that 65%-87% of medication errors reported occurred during prescribing or administration, the two most common errors being the wrong dose prescribed or the wrong calculated dose being administered. The administration of medicines is a pertinent aspect of the registered nurses’ role with up to 40% of their time spent on the core skill (Armitage and Knapman, 2003). The numerical ability of both registered nurses and student nurses is a concern that is widely recorded in nursing research and literature (Kapborg, 1994; Hutton, 1998; Wilson, 2003; Sandwell & Carson, 2005). However numerical ability is not the only factor associated with poor maths skills amongst nurses, as confidence and anxiety are major contributing factors (Ma, 1999; Evans, 2000; Sabin 2001). O’Shea (1999) found that nurses who have poor maths skills will contribute to the increasing risk of medicine errors. Poor numerical ability can ultimately affect the welfare of patients, as nurses’ who are unable to calculate medicines correctly will administer incorrect doses to patients leading to harm and in some cases even death. It is clear that improvements in nurses’ numerical ability resulting in less medication errors will contribute to the reduction in spending and increase patient safety.

**Background**

Mathematical incompetence and poor numerical ability of both student and qualified nurses’ has become the subject of many research papers and it is apparent that it is a problem. Initially the focus of the papers was on the mathematical ability of nurses’, with some exploring how anxiety can affect confidence and ability of nurses’ to perform calculations. More recently researchers have begun to explore what is being done within Higher Education (HE) nursing programmes to help nurses’ improve numerical skills. The majority of the research undertaken focuses on pre-registration student nurses’, with others looking at the mathematical ability of qualified nurses’. There is very little research undertaken that considers what the NHS and health sector employers are doing to help address the problem. Three themes emerged from the review of the literature Numerical Ability of Nurses’, Maths Anxiety and Self Efficacy and Strategies to improve medication calculation skills of nurses’.

**Numerical Ability of Nurses’**

Numerical ability of nursing students
has been causing concern for the last 25 years (Mcmullan et al. 2010). Grant- dell-Niemi et al. (2001) undertook a quantitative study in order to ascertain the basic mathematical proficiency and medication calculation skills of third year student nurses, upon completion of the programme. Although twenty-eight nursing colleges were invited to participate in the study, only eight institutions agreed to it in the main, as the aspects were slightly poor, she felt the study to be mutually beneficial as the students would get extra help with numeracy via the drop in sessions. The results were consistently poor, she felt the study to be mutually beneficial as the students would get extra help with numeracy via the drop in sessions. The participants said they preferred test groups, a control group (n=92) where the students enrolled on the course would have failed if the pass mark had been set at 80%. The students nurses were slightly better, with 83% failing the arithmetic test and 99% failing the drug calculation test. The findings showed that student nurses were statistically worse when performing drug percentages and infusion rate calculations, this reflected findings in other studies (Olidridge et al. 2004; Brown, 2006).

Maths Anxiety of Nurses’

Ma, (1999) defines maths anxiety as the general lack of comfort that someone suffers when they are asked to perform maths, particularly, it may also have a strong component of helplessness or tension when one is asked to deal with numbers or shapes. People may experience physical discomfort, such as nausea, giddiness and psychological symptoms including temporary memory loss or sense of failure or dread (Sredl, 2006). Elycock, (2012) established that a quarter of the population in the UK suffered with maths anxiety which equates to approximately 2 million children in England. A study undertaken by Bull, (2009) to identify if maths anxiety interfered with math cognition. The sample consisted of fifty-three student nurses’ from a pre-registration nursing course in an HEI in the UK, the mean age of the sample was twenty-five years, with the majority being female (n=57). Findings suggest that students experienced both physical and psychological reactions in relation to their performance or lack of performance in the tests, as they felt physically sick. There were a significant number of participants who experienced maths anxiety, this possibly had a negative effect on their ability, however there are limitations to this study in that a small convenience sample was used (Lobion-do Wood and Haber, 2009). These findings are mirrored in a more recent quantitative study commenced by McMullan et al. (2012) which explored the effectiveness of an intervention and teaching strategies (practical skills session, online maths tutorial, face to face maths tutorials, workbooks, drug calculation booklets and library). The findings suggest that students who failed the numeracy tests were significantly more anxious and less confident in performing maths and drug calculations. It is important to note that Wright (2008) continues to research this.

Pre and Post Intervention Maths Test

The tests were designed by the researchers, the tests were Pre and post, to firstly diagnose the maths ability of the participants, and the content of them were based on the numerical component and relating to the course. As part of the study was to ascertain if maths ability had improved post-intervention, it was imperative that the pre and post results were compared. The researchers, as to have different questions post-inter- vention could lead to the second test being easier or harder, leading to false results (Cohen et al. 2007). The maths tests comprised of a variety of maths questions from addition to long division, as the participants were qualified nurses and achieved an average score on the numerical component and relating to the course. The researchers attempted to note that Wright (2008) continues to research this.

Methodology

The study is a mixed method design, the pre and post intervention maths tests used quantitative data, the questionnaire consisted of fifteen statements, for written explanations, this is a common approach. Of helplessness or tension when one is asked to deal with numbers or shapes. People may experience physical discomfort, such as nausea, giddiness and psychological symptoms including temporary memory loss or sense of failure or dread (Sredl, 2006). Elycock, (2012) established that a quarter of the population in the UK suffered with maths anxiety which equates to approximately 2 million children in England. A study undertaken by Bull, (2009) to identify if maths anxiety interfered with math cognition. The sample consisted of fifty-three student nurses’ from a pre-registration nursing course in an HEI in the UK, the mean age of the sample was twenty-five years, with the majority being female (n=57). Findings suggest that students experienced both physical and psychological reactions in relation to their performance or lack of performance in the tests, as they felt physically sick. There were a significant number of participants who experienced maths anxiety, this possibly had a negative effect on their ability, however there are limitations to this study in that a small convenience sample was used (Lobion-do Wood and Haber, 2009). These findings are mirrored in a more recent quantitative study commenced by McMullan et al. (2012) which explored the effectiveness of an intervention and teaching strategies (practical skills session, online maths tutorial, face to face maths tutorials, workbooks, drug calculation booklets and library). The findings suggest that students who failed the numeracy tests were significantly more anxious and less confident in performing maths and drug calculations. It is important to note that Wright (2008) continues to research this.

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the participants were already attending for other purposes, they felt this was preferable than going to their place of work, they were interviewed once for no longer than an hour by the researcher, the interviews were recorded.

Data Analysis
Pre and post intervention test scores and the questionnaires were analysed using descriptive statistics. Both test results were recorded on an excel spreadsheet and the mean score was analysed using SPSS version 19, using a Two-Sample t-test. The t-test was used to ascertain if ability had improved following the numeracy drop-in sessions. The questionnaire responses were collated and most frequent responses were recorded on table format and transferred into percentages, this is common in descriptive statistics. The interviews were transcribed by the researcher verbatim immediately following the interviews, the transcripts were then coded using a line by line analysis, similar transcribed. The transcripts were then sent to the interviewed participants to validate that they had been correctly transcribed. The transcripts were then coded using a line by line analysis, similar data was then grouped enabling three themes to be generated.

Results
Pre and Post Intervention Maths Test
The sample for the pre and post-intervention maths test consisted of 13 registered nurses on a nurse prescribing course, all participants were female. The completion rate of the pre-intervention maths test was 92% (n=12) and the post-intervention maths test 100% (n=13), as this involved comparative analysis the post-intervention result of candidate number forty was disregarded. Out of the twenty questions participants had the greatest difficulty in long division, percentages, conversions, paediatric drug calculations and time (see figure 1).

The post intervention maths scores identified that the maths ability of the sample had improved following attendance at the drop in sessions, in comparison to the pre-intervention scores, with scores ranging from 9.5 – 20, with a mean score of 16.5/20 (82.5%) see figure 2.

The SPSS, Version 19 was used to ascertain and compare the mean scores for the pre and post-intervention maths tests, the pre-intervention mean was 65% compared to 82.6% post-intervention, see figure 3.

Discussion
Theme 1 – Personal Maths Experience (Pre-intervention).
The participants were asked about their maths confidence in the questionnaires and interviews 60% (n=3) stated they had low confidence in maths. The pre-intervention maths score did not reflect this though, participants 1 and 29 stated they were not confident with maths but both achieved good scores 65% and 77.5%, this suggests they may have greater ability than they think. These findings are similar to a study by Wright (2008) where students who had low maths confidence did not do as well as they thought. The test score for candidate 15 was 45% this low score reflects the impact of low confidence on her ability. Many research studies emulate this finding that low confidence can have a detrimental effect on ability (Ma, 1999; Andrew et al, 2009; Bull, 2009).

Candidate 32 when asked about her personal maths confidence in the interviews echoed her response in the questionnaire:

“I am very confident with maths, and because I am confident, I enjoy doing it.”

Whereas candidate 30 stated in the questionnaire she was confident but when discussed in the interview she became apparent that she was not as confident as candidate 32:

“On a basic level on a relaxed day, I feel ok with it.”

This reveals that maths confidence can mean different things to different people, confidence can be in the complete subject of maths, or it can be the basic maths that participants are familiar with that makes them confident, but they themselves are under confident when taken out of their comfort zone. Andrew et al (2009) support this as they found that students are more confident with basic maths formulas than in calculations that require multiple steps.

When exploring maths anxiety, questions were asked in relation to being scared of maths. Participants responded positively in the main to the statement ‘maths does not scare me’ (60%, n=3), although 40%, n=2, did not. It is unfortunate that these two candidates declined to be interviewed, as the extent of their maths anxiety is unclear. A blank mind relating to maths can be a symptom of maths anxiety (Ma, 1999), it is interesting to note that all of the participants in the questionnaire agreed that ‘their minds went blank and they cannot think clearly when doing maths’. This could be interpreted that all of the participants experienced maths anxiety; conversely the interview responses were different in that two of the candidates displayed no anxiety towards maths:

“It just doesn’t scare me as such”

“Maths doesn’t frighten me at all”

Candidate thirty expressed that she was confident with maths, but in the interview she described feelings of maths anxiety:

“That first day when you gave us the exam, I thought ‘oh my god’ and I got really clammy and sweating thinking ‘oh I can’t do it’.”

It is unclear from the questionnaire and interview responses whether the participants truly understood what maths anxiety meant and whether this ‘blank mind’ related to test anxiety as opposed to maths anxiety. It would appear from candidate twenty-nine’s interview that what she experienced was test anxiety as the fear was experienced immediately before the test (Zeidner, 1998) and when asked about maths confidence she stated she was “ok”, and her pre-intervention test score of 77.5% does not compare to the popular belief that maths anxiety leads to poor maths ability (Bull, 2009; Mullan et al, 2012). In the questionnaire participants were asked to respond to the statement, ‘maths tests scare me’, However 80% (n=4) of the candidates agreed with the statement, from the questionnaire alone it is impossible to ascertain if it was the subject maths or the test which was scary, therefore this was explored further in the interviews. All of the candidates interviewed stated that it was the word test they found scary not maths:

“Test is scarier, it’s the test that throws
people's confidence and panic them? Therefore the researcher would suggest that 80% [n=4] believed they were good at maths in the questionnaire but in the interview, findings concurrent with a study by Walsh, (2008), whereas it would appear that candidate fifteen has maths anxiety, as in the questionnaire she stated "I don’t panic where maths is concerned", this is typical of maths anxiety (Ma, 1999).

Personal Maths Ability

The pre-intervention scores identified that the maths ability of the sample were relatively poor with scores ranging from 8.5 – 18.5 out of 20, with a mean score of 13 (65%). These findings are not unique as many of the studies in the literature review presented similar results (Hutton, 1998; Grandell-Niemi et al, 2001; Polifroni et al, 2003; McMullan, 2010). These scores do not reflect the views of the participants as 60% (n=3) believed that they were good at maths. The main areas of difficulty encountered by the participants in the pre-intervention test were long division (100% error rate), percentages (83% error rate), conversions (75% error rate), paediatrics (67% error rate) and time (58% error rate). The first four are regarded as being critical (Brown, 2006) and Sherriff et al, (2011) to be the calculation skills required for medicines, however they are frequently the areas nurses’ struggle with. The fifth, time is not generally an issue for nurses’ and it is perceived that the construction of the question may have led to some confusion. These results indicate that basic mathematical principles are the basis of nurses’ difficulties.

The participants in the main (60%, n=3), believed they had good maths ability, but test scores varied with the lowest being 45% for candidate fifteen, who deemed herself "experimented with" and 77.5% for the remaining participants. The responses in the interviews of candidates twenty-nine and thirty-two corroborated with these results: "Average, I am not high flying" "I have good abilities" Except candidate thirty believed she was good at maths in the questionnaire but in the interview: "Always used to be my lowest mark, I struggled with maths and got through." In further exploration of this anomaly she discussed her experience of maths during her secondary education: "Part of it was to do with my teacher... I was forever helping him out." Eastwood et al, (2011) and McMullan et al, (2012) advocate that school experiences are a major contributor affecting maths confidence and ability, however her pre-intervention score was 77.5% suggesting good ability.

Theme 2 – Effect and Experience of Drop-in Sessions

All of the participants felt it was important to take advantage of this opportunity; this is supported by Maag, (2004) who found in her study that a one off hour-long session was insufficient to correct the maths problems of the sample. When asked why they had chosen to attend them, the responses were similar: "To improve result from initial test" "Refresh and practise" "Build my confidence up" "Help prepare for the exam at the end" The importance of reviewing and practising skills for registered nurses is stressed by McMullan, (2010) because limited use of certain numerical skills on a daily basis leads to them becoming rusty and loss of expertise. Hutton, (1998) suggests that revision is most helpful to nurses’; this was reiterated by candidate thirty as the main reason for attending. "I needed the practice so I came to do what I needed; to be sure I was as good as I can".

In the questionnaire responses 80% (n=4) agreed that their confidence had improved as a result of the numeracy drop-in sessions, this was echoed in the interviews: "My confidence has improved” "Yes my confidence has improved, that’s why I kept coming back, once you become familiar your confidence grows and anxiety level drops” "Definitely my confidence has improved” McMullan et al, (2012) claims that there are both theoretical remedies to improve maths confidence, e.g., providing positive encouragement and constructive feedback in a safe environment. As a sufferer of low maths confidence, I wanted to create a supportive learning environment that allowed errors to be made without fear of humiliation; this is considered a must in increasing low maths confidence (Bull, 2009). In the paired two-sample t-Test the t-stat was 3.933, as this is greater than the critical t-value 1.755, from the one-tailed test, maths ability of the participants had improved. However Harmon, (2010) postulates that the two-tailed test is more stringent, and therefore more accurate. The critical t-value in the two-tailed test was 2.200 which is lower than 3.933, indicating with 95% certainty that the participants pre-intervention scores had improved statistically. In comparison of the pre and post-intervention scores 92% (n=11) had improved their pre-intervention result (n=14) had achieved the same score. The mean increase in scores from pre to post-intervention was 3.5 marks, the biggest improvement was from 9/20 (45%) pre, to 20/20 (100%) post. These findings are very similar to studies by Wright, (2006) and McMullan et al, (2010). However it could be argued that these results are not a reflection of the drop-in sessions but due to the participants knowing they would be tested and preparing for the end of course exam, meaning they had spent more time revising (Wright, 2008).

Therefore the participants were asked if they thought their maths ability had improved, 80% (n=4) agreed that it had, the responses in the interviews mirrored the questionnaires: "The exam results help verify that my ability has improved” "It’s improved” "My ability has definitely improved” The reasons for them improving, increased practise, revision of skills, working together, was common in other studies (Hutton, 1998; Wright, 2005; Sherriff et al, 2011). The greatest improvement was where students had achieved 100% post-intervention; this would deem them competent (Brown, 2006; Jukes & Gilchrist, 2006). However only 42% (n=5) achieved this post-intervention which is concerning when the NMC (2006) stipulate nurse prescribers should pass the numeracy component of the course at 100%, indicating further research is necessary.

Summary

From the findings it is clear that the numeracy drop-in sessions did increase nurse’s maths confidence and ability. From the themes it is apparent that the numeracy drop-in sessions are an effective drop-in session strategy. The levels of maths anxiety need to be taken into account, as do the type of formulas to be included in the sessions. In my opinion the results in drop-in session will continue will changes will be made in light of this study.

Limitations

Limitations to the study are the small sample size, undertaken in a single HEI in the UK, all of the participants were female and the age range was limited; these limitations may prevent the findings being generalised, but the teaching strategy could be adopted by other HEI’s.

Conclusion

It was interesting to note that the participants had varying degrees of maths ability depending on their schooling and life experience; however none of the participants pre-intervention and only five post-intervention achieved the 100% pass mark required by the NMC (2006). As discussed, without a standardised assessment tool and pass grade in numerical competence of nurses it is difficult to ascertain if the participants are competent with maths. These findings are similar to other studies that have researched maths ability (Lerrill, 1999; Grandell-Niemi, et al, 2001; Eastwood et al, 2011). The maths anxiety of the participants was difficult to ascertain, this could be down to my data collection tool, or the lack of understanding of maths anxiety on the participants part. Self-confidence amongst the sample varied, and low self-confidence did not always affect ability, results that are congruent with a study by Wright, (2008). It is pleasing to note that all of the participants found the drop-in sessions beneficial in both improving maths confidence and ability and that 92% improved their post-intervention test score. Although not all of the students on the nurse prescriber’s module passed the exam at 100% on first attempt, it would appear that the number of students passing at first attempt has increased following the numeracy sessions. In light of this, the sessions have now become a regular feature within the nurse prescribing module and have even been reported as best practice in the North West Nurse Prescribers Network. However as a result of undertaking the study there are some recommendations for change to make regarding numeracy drop-in sessions.

The study sampled thirteen registered nurses on a course in the School of Health; however the number of pre and post-registration students within the school is 3761, with 1830 being pre-registration student nurses’. All of these students will undertake medicine calculations within their role and in light of studies relating to nurses’ maths ability (Grandell-Niemi, et al, 2001; McMullan, 2010) it seems implausible that they would not experience similar difficulties. The findings from the pilot study retrieved similar results, it seems logical then to perform a larger researcher study with a greater sample size and a mixture of pre and post-registration student nurses’. This would lead to a more varied age range and would add the male perspective to the research.

Researching the numeracy drop-in sessions after adding context to the sessions, by use of drug charts and equipment, would allow comparison of the findings from this study with the findings of the new format to ascertain if the ability of the students and those achieving 100% had increased, and if the new format enabled the students to recognise the unrealistic errors made. It would also be interesting to look at the exam scores of the prescribers after they had attended the sessions to see if the pass rate had improved. The maths anxiety was difficult to assess in this study, which was due to the data collection tools, it would be useful to use a recognised maths anxiety scale, like the maths attitude scale or the maths anxiety rating scale as this would help me to assess the gravity of the issue within my sample.


