PEER REVIEW HISTORY

ARTICLE DETAILS

TITLE (PROVISIONAL)	Improvement of drug dose calculation by classroom teaching or e-learning: A randomized controlled trial in nurses
AUTHORS	Simonsen, Bjorg; Daehlin, Gro; Johansson, Inger; Farup, Per

VERSION 1 - REVIEW

REVIEWER	Kelley Miller Wilson DNP(c) RN University of Maryland School of Nursing Baltimore, MD United States
REVIEW RETURNED	28-Jul-2014

GENERAL COMMENTS	Well written article with good information extracted from the study. I wonder if the authors have thoughts for future studies? I also wonder if there was any consideration of generational diversity when placing students in on-line vs in-class educational sites. (Could older students placed in the on-line format have been uncomfortable or intimidated by the technology?) A couple of concerns regarding specific statements. Line 2 of the abstract--"Even some experienced nurses MAY (should be added) struggle....." Page 13/18 paragraph 3 starts "I"; did the authors mean to say "In"? Page 3/18, paragraph I; "Most health professionals....." should that be changed to "MANY"? I am glad to see some quality research being completed on this most important study. Nicely done!

REVIEWER	Professor Keith W. Weeks (Professor of Innovation & Engagement in Healthcare Numeracy & Education): RN, PhD, BSc (Hons), BEd, Dip.N., RNT, SFHEA University of South Wales, UK I have no collegial, research or publication associations with the authors. I am Professor of Innovation & Engagement in Healthcare Numeracy & Education, University of South Wales and Research & Design Director of Authentic World Ltd (a spin-out company of University of South Wales & Cardiff University, UK). A 22-year programme of translational research (1992-2014) facilitated the design and development of safeMedicate, a virtual authentic medication dosage calculation learning & diagnostic assessment environment that is currently informing the curricula of circa 65% of UK pre-registration nursing programmes and the learning and competence assessment of circa 150,000 healthcare students & practitioners across six countries in four continents (UK,

	USA, Canada, Australia, UAE, Poland).
REVIEW RETURNED	03-Aug-2014

GENERAL COMMENTS	This paper contributes to the growing international literature focusing on numeracy and medication dosage calculation problem-solving competence and education in nursing and medicine. I recommend that with the suggested recommendations this paper will further inform nurse and physician education and practice within this patient-safety critical domain. This RCT study was undertaken circa 2007-2009. Cited literature is included for the period 1995-2013. However more recent research published since this period would further inform this paper and reflect contemporary issues within the field. The problem of poor math's skills and its relationship to competence development in medication dosage calculation problem solving is a universal feature of international nurse and physician education and practice. In its current form the paper adds to the plethora of literature that focuses on the calculation component of medication dosage calculation problem solving and advances the domain of risk-of-error measurement. While the calculation element of the problem solving process is critical to the competence development of registered nurses and physicians and patient safety, more recent work in the field has articulated calculation competence within a wider medication dosage calculation problem-solving competence model that is informing international education and clinical practice. Framing this paper within this wider competence context will better articulate the relationship between conceptual, calculation and technical measurement competence and the application of mathematics to nurse and physician education. I have five points and recommendations: Point 1: This RCT study was undertaken circa 2007-2009. Cited literature is included for the period 1995-2013. Recommendation 1: More recent research published in 2013-2014 would further inform this paper and reflect contemporary competence and education issues within the field: e.g.: - Safety in Numbers: www.nurseeducationinpractice.com/content/safety - Coben, D. & Weeks, K.W. (2014). Meeting the mathematical demands of the safety-critical workplace: medication dosage calculation problem solving for nursing. Educational Studies in Mathematics: 86, Pages 253-270. Point 2: The authors have designed a RCT that robustly measures the relationship between exposure to two medication dosage calculation education methods (classroom and on-line) and pre and post exposure drug dosage calculation performance on a MCQ assessment. Recommendation 2: Further information on the design, construct and content of both of the education interventions and the MCQ will better inform a review of the pedagogy and test structure informing the study and will improve the prospect of accurately replicating the study.

	Point 3: In common with much of the literature within the field, this paper focuses predominantly on the mathematics and calculation element of the medication dosage calculation problem-solving process (and confidence in solving this element of the medication dosage calculation problem solving process). While this element is critical to the competence development of registered nurses & physicians and patient safety, more recent work in the field has articulated calculation competence within a wider medication dosage calculation problem-solving competence model. Recommendation 3: Framing this paper within this wider competence context will better articulate the relationship between conceptual, calculation and technical measurement competence and the application of mathematics to nurse & physician professional education and competence assessment. Point 4: Within the context of calculation and conceptual competence noted in Point 3, the authors in common with other work in the field state that "Drug dose calculations are not advanced in a mathematical sense. The basic arithmetic functions of addition, subtraction, multiplication or division are needed to decide decimals and fractions. What seems to be challenging is to conceptually understand the difference in information from the concentration denomination: percent or mass per unit volume, or the ability to set up the right calculation for the relationship between dose or mass, volume or amount and concentration or strength. (p.11)" The significance of this problem cannot be overstated and if the healthcare professions are to collectively overcome the problem of dosage calculation error in clinical practice then reductionist approaches that separate the learning and assessment of the three aspects of medication dosage calculation problem solving competence must be addressed. The problem of failure to: (1) conceptually understand medication dosage calculation problems, discriminate between the essential numerical information required and the setting up of accurate equations (when problems are both articulated in an abstract word based form and in a clinical context) and the manifestation of conceptual errors (failure to understand the dosage problem to be solved) is significant and must be evaluated in conjunction with evaluation of (2) calculation competence (computation of an accurate numerical value & measurement unit for the required dose/rate of administration and diagnosis of arithmetical operation & computation errors and arithmetical dropped stitches) and (3) technical measurement competence (measurement of an accurate dose/rate of medication within an appropriate vehicle: syringe, IV infusion pump etc.). Recommendation 4: To further inform this key point, further review of medication dosage calculation competence modelling, error diagnosis and MCQ design and of authentic learning and assessment environment design is recommended. For example see: - Weeks, K.W., Hutton, B.M., Coben, D., Clochesy, J.M. & Pontin, D. (2013). Safety in Numbers 2: Competency modelling and diagnostic error assessment in medication dosage calculation problem-solving. Nurse Education in Practice, Volume 13, Issue 2, March 2013, Pages e23-e32. - Weeks, K.W., Hutton, B.M., Young, S., Coben, D., Clochesy, J.M. & Pontin, D. (2013). Safety in Numbers 3: Authenticity, Building knowledge & skills and Competency development & assessment: the ABC of safe medication dosage calculation problem-solving pedagogy. Nurse Education in Practice, Volume 13, Issue 2, March 2013, Pages e33-e42.

	- Weeks, K.W., Higginson, R., Clochesy, J.M. & Coben, D. (2013) Safety in Numbers 7: veni, vidi, duci: a grounded theory evaluation of nursing students' medication dosage calculation problem-solving schemata construction. Nurse Education in Practice, Volume 13, Issue 2, March 2013, Pages e78-e87. Point 5: The authors are to be congratulated on the development of a risk-of-error measurement framework. Recommendation/observation 5: This advances the pedagogy and patient-safety agenda within the field and adds a further dimension to evaluation of competence within this patient safety-critical domain.

REVIEWER	Kay Savik School of Nursing, University of Minnesota, USA
REVIEW RETURNED	22-Aug-2014

GENERAL COMMENTS	Improvement of drug dose calculation by classroom teaching or e-learning: A randomized controlled trial in nurses. This appears to be a nicely conducted study of the effect of classroom versus e-learning on drug dose calculations. I have some questions, however, on the analysis and presentation of results. 1. The sample size was calculated on the basis of the difference between 2 groups. However, the randomization is said to be stratified. Was it actually? Or, was their workplace just collected as data. If there was actually a stratified randomization, the sample size calculation has to account for that, as does the analyses. 2. The term "job size" is vague, how about percent effort or something similar? 3. Why was time spent studying categorized, and why were the cut-points chosen as they are? Was it due to distribution? Categorizing a continuous variable can result in creating false associations or masking significant associations that are there. How was this variable treated in analysis? Was it dummy coded as would be appropriate? 4. Please add at the bottom of each table the statistical test that led to the p-values. 5. There needs to be some justification of comparison of 3 point scales as interval data. Were they normally distributed? Many of the SDs indicate they are not. Were they compared using a Mann-Whitney U? refer to item #4 6. When looking at the comparison in differences between pre and post score, what analysis was done? Did you consider an ANCOVA adjusting for the baseline, which would be standard? 7. In the multiple regression, what is the learning outcome, is it the post score or the difference score? 8. I am concerned about using a multiple regression on a variable that is a 3 point scale or differences from pre to post. How is that difference distributed? Did you check regression diagnostics for indications of violation of assumptions?

VERSION 1 – AUTHOR RESPONSE

Reviewer Kelley Miller Wilson DNP(c) RN

Thoughts for further studies.
Response to the reviewer:
Is added in the Discussion section, under Importance for practice, page 13.
Generational diversity - age of participants.
Response to the reviwer: We have no information to support such an effect. There were no difference in age of the participating nurses in the two groups, and age was not associated with the learning outcome for either of the groups. Further information was also collected, but not reported as they were of no statistical significance for the results: frequency of data use: at work, internet, Office-programs; and motivation for the two courses before and after course.
Statement comments: are corrected in the text on pages 2, 3, and 13.

Reviewer Professor Keith W. Weeks RN, PhD, BSc (Hons), BEd, Dip.N., RNT, SFHEA
Comment about research after the study was performed.
Response to the reviewer: A wider competence context is included in the ciscussion section.
Point 1: More recent research published in 2013 - 2014.
Response to the reviwer: There are different views concerning citing of more recent research than that available at the time of the study in the background section. More recent research published in 2013-2014 is included in the discussion section, page 12.
Point 2: Further information on the design, construct and content of both the education interventions and the MCQ.
Response to the reviewer: Information in more detail is included in the Methods section, under Interventions page 4, and the MCQ for both pre and post course tests are referred to in the Outcome section at page 5, and enclosed as Additional file 1.
Point 3: Framing the paper within a wider competence context.
Response to thr reviewer: The relationship between conceptual, calculation and technical measurement competence is included in the discussion sections, page 11.
Point 4: Further review of medication dosage calculation competence modelling, error diagnosis and MCQ design.
Response to the reviewer: This is included in the discussion sections, see point 3.
Point 5: Development of a risk-of-error measurement framework.
Response to the reviewer: This has been made more clear in the section Article summary, page 2, and in the discussion section, under importance for practice, page 12. We are thankfull for the acknowledgement.

Reviewer Kay Savik
1. Randomization and stratification
Response to the reviewer: Yes, it was actually stratified. The stratification was done to ensure that the nurses from different working places in hospitals and primary health care were equally randomized to the two learning groups, to account for possible differences in calculation experience at work. In such cases it is not common to take into account the stratification in the sample size calculation. In the analyses, we were not interested in the learning outcome for the different strata. A possibility could be to use the strata as categorical variables in the multivariable analyses, but since we did not intend to investigate a difference in learning outcome between the strata, this was not considered necessary.
2. The term Job size.
Response to the reviewer: The term is rephrased to "part time job" (1= full time).
3. Time spent studying
Response to the reviwer: This was predefined as 3-hour intervals, as it was regarded too difficult to

specify the exact time used. The variable is linear, and analyzed as such. A dummy coding would not be appropriate in this case. We realize that the variable is difficult to interpret, and discussed whether to include the 6 hours classroom day , or just use the self study time for both groups. After reading the comments from the referee, the variable is taken out of the paper.
4. Statistical tests for each p-value.
Response to the reviewer: The tests used are added under each table.
5. Comparison as interval data.
Response to the reviwer:Non-parametric test was used. Mann-Withny U-test.
6. Difference between pre and post score.
Response to the reviewer: The test used was linear regression with ajustment for baseline. ANCOVA adjusting for baseline is a variant of linear regression. 7. Multiple regressions.
Response to the reviewer: The learning outcome is the difference score. The pre-test score is adjusted for as an independent variable, as described by Twisk, Jos W. R.. Applied Longitudinal Data Analysis for Epidemiology: A Practical Guide. West Nyack, NY, USA: Cambridge University Press, 2003. p 185.
8.The difference from pre to post was a five-point scale (not 3-point scale). We are aware of the problem using a 5-point scale as dependent variable and have discussed the problem with a statistician who judged it as satisfactory. The residuals were tested for normality distribution.